United States Department of Agriculture
Forest Service

# Soil Resource Report

# Upper Briggs Restoration Project

**Rogue River-Siskiyou National Forest,**
**Wild Rivers Ranger District**

**Myers Creek valley bottom ultisol. Photo Credit: Joni Brazier**

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# Introduction

This report analyzes the effects to the soil resource, including slope stability and soil productivity, from proposed activities in the Upper Briggs Restoration Project. Proposed activities include implementing group selection, patch creation, variable density and radial thinning, and re-introducing fire through under burning, to develop and enhance late seral habitat, restore pine-oak communities, sensitive plant habitat, meadow systems, and riparian reserves, as well as creating and maintaining strategically located fuel breaks, and decreasing road impacts through storm proofing, storage, or decommissioning.

## Proposed Project Location

The Upper Briggs Restoration Project is located approximately eleven miles west of Grants Pass, Oregon. The planning area boundary is the Upper Briggs Creek 6$^{th}$ level watershed, entirely within the Briggs Creek 5th level watershed. Elevations ranges from 2,000 feet on the valley floor to approximately 4,400 feet on both Taylor Mountain at the northwest boundary of the watershed and Onion Mountain on the southeast boundary. The analysis area for the soil resource is the planning area for the Upper Briggs Project, and more specifically, areas directly or spatially near proposed project activities, referred in this report as the project area.

## Specialist Review Methodology

### Spatial Scale

Slope stability effects focus on areas directly within, and upslope and downslope of proposed activities, since slope stability is affected by actions that would occur directly or immediately adjacent to the slope.

Soil productivity effects focus on soils that are directly within proposed activities, since soils are affected by actions that occur directly upon them and not from actions that occur spatially disconnected from them.

### Temporal Scale

Slope stability short term effects first 1-3 years; captures direct impacts from vegetation changes or disturbance that can trigger instability due to changes in precipitation/soil interaction on a site. Long term impacts starting at 7 to 10 years; captures changes in root strength on a slope, as roots from cut conifers decay and can cause shallow groundwater piping, etc., and roots from any remaining trees potentially expand in extent.

Soil productivity effects short term effects first 1-5 years, which would include the expected recovery of organic matter and nutrients in soils that have experienced disturbance, such as displacement, erosion, or shallow surface compaction at a level that is not considered detrimental. Long term effects are expected to last 25 years or greater, and refer to soil effects that are considered detrimental, such as deep compaction and extensive displacement and loss of the A horizon.

### Analysis Methods and Assumptions

#### *Slope stability and erosion risk mapping*

Modelling was conducted utilizing tools in ArcMap to estimate the relative risk of slopes in the planning area to instability and erosion. Slope gradient, slope aspect, slope curvature, and upslope contributing area were used to model the spatial variability of soil properties. The use of individual terrain attributes have proven useful for soil-landscape modeling and has been demonstrated that landform element classifications can aid in delineating soils (Pennock et al. 1987, Park et al. 2001). This modeling of terrain attributes provides for a site-specific inventory (based on a 10 x 10 meter grid) that was modeled using digital terrain information and modeling tools within ArcMap, a geographic information system (GIS). The base set of data used to model terrain characteristics is a Digital Elevation Model (DEM). These DEMs meet U.S. Geological Survey (USGS) standards for content, format, and accuracy. DEMs for lands in the conterminous United States are produced in a 7.5-minute latitude by a 7.5-minutes longitude quadrangle format, with elevations spaced at 10 meter intervals (horizontally).

The following discusses the tools used in modeling the terrain characteristics used in this analysis. These attributes include slope gradient, slope aspect, slope curvature, and upslope contributing area. Table 1 displays the terrain parameters used to model the risk rating for slope stability and erosion.

The slope gradient tool in ArcMap utilizes the DEM to identify the steepest downhill slope for a location on a surface. Slope gradient was measured as percent slope. Percent slope of an area is a measure of the change in height (elevation over a measured distance). Slope is calculated for each cell in a raster map. It is the maximum rate of change in elevation over each cell and its eight neighbors. The lower the slope value, the flatter the terrain while the higher the slope value, the steeper the terrain.

The slope curvature tool was used as measure of the shape of the slope. The curvature of a surface is calculated on a cell-by-cell basis using a surface composed of a 3 cell by 3 cell window. The output of the curvature model can be used to describe the physical characteristics of a drainage basin in an effort to understand erosion and runoff processes.

A positive curvature indicates that the surface is upwardly convex at that cell. A negative curvature indicates that the surface is upwardly concave at that cell. A value of zero indicates that the surface is flat. Curvature of the slope affects the acceleration and deceleration of flow and, therefore, influences erosion and deposition. In this analysis, curvature was classified based on the the following: Concave slope has a curvature value of < (-3); convex slope has a curvature value of >3; linear slope has a curvature value of (-3) - 3.

Upslope contributing area is also termed "flow accumulation". The accumulated flow is a value based upon the number of cells flowing into each cell in the raster. The flow accumulation tool utilizes slope aspect to determine the direction of flow for each cell. The results of the flow accumulation tool were then used to create a stream network by applying a threshold value to select cells with a high accumulated flow. This method of deriving accumulated flow from a DEM is presented in detail in Jenson and Domingue (1988). By adjusting the threshold value, the accumulated flow model can identify the areas where streams originate and thus identify headwall areas where instability might be a concern.

**Table 1. Description of terrain physical parameters used for modelling risk rating.**

| Terrain Feature | Value | Rating |
|---|---|---|
| Curvature | < (-3) | Very High |
| Slope | > 65% & > 2.5 acres | Very High |
| Flow Accumulation | | |
| Slope | > 65% | High |
| Flow Accumulation | > 2.5 acres | High |
| Flow Accumulation | 0.2 – 2.5 acres & 25 – 65% | Moderate |
| Slope | | |
| Flow Accumulation | < 0.2 acres & < 30 - 65% | Moderate |

| | | |
|---|---|---|
| Slope | | |
| Flow Accumulation<br>Slope | 0.2 – 2.5 acres & < 25% | Low |
| Flow Accumulation<br>Slope | < 0.2 acres & < 30% | Low |

The accuracy of the data used for modeling and analysis under this NEPA analysis is deemed to be adequate. This is supported by field verification of random areas within the project area, and professional opinion based on years of experience on these soil types.

***Soil water holding capacity mapping***

Soil water holding capacity mapping was completed across Oregon and Washington by the Department of Crop and Soil Science, Oregon State University, Corvallis, OR and the USDA Forest Service - Region 6 Office, Portland, Oregon, utilizing physical soil attributes from soil surveys that are available. The following paragraph from the metadata in GIS explains the methods used to develop this mapping:

"Available water holding capacity to a depth of 150cm was calculated from the best available soil information across the Pacific Northwest Region; units are mm. The information came from NRCS Soil Surveys published in the Soil Survey Geographic Database (SSURGO) at a scale of 1:24,000 and from USFS Soil Resource Inventories (SRIs) at a scale of 1:63,360 where SSURGO is not available. Calculations of Available Water Holding Capacity (AWHC) – that soil water available for plant uptake, were determined by soil horizon based on the following formula: AWHC = (W1/3 –W15) x (Db 1/3 ) x Cm / 100AWHC = volume of water retained in 1 cm3 of whole soil between 1/3-bar and 15-bar tension; reported as cm cm-1 [numerically equivalent to inches of water per inch of soil (in in-1)]W1/3 = weight percentage of water retained at 1/3-bar tensionW15 = weight percentage of water retained at 15-bar tensionDb1/3 = bulk density of <2-mm fabric at 1/3-bar tensionCm = rock fragment conversion factor derived from: volume moist <2-mm fabric (cm3) / volume moist whole soil (cm3)The SSURGO survey has lab data of available water holding capacity by horizon. For the SRI, we used a soil texture relationship for W1/3 – W15 based on NRCS lab data for similar textures. We use a bulk density of 1.00 g/cc for surface and 1.25 g/cc for subsurface (0.75/1.00 g/cm for soils influenced by ash). All calculations on the output map are for the dominant soil in the soil map unit only. A single soil map unit may contain a complexes of 2-3 distinct soil types, some similar and some contrasting in their attributes. Similar output maps can be made for the minor components in the soil map unit."

The mapping used for the Upper Briggs analysis utilizes the calculations based on the dominant soil in the soil map unit. Using the dominant soil type for the landscape-scale size of the analysis area captures the soil characteristics that are most commonly encountered across the landscape and are considered adequate for this analysis. Project design and layout at the site scale would further take into account the variability of soils at the site level, manifested in the vegetation communities they are supporting.

***Other Assumptions***

This soils analysis assumes the conservative approach that some form of mechanized equipment has the potential to be used for implementation across all of the proposed treatment acres in each action alternative. Project design criteria and mitigation measures identified for this project ultimately limit this extent to a smaller area based on resource protection requirements and needs, as well as equipment and economic feasibility which can vary by equipment, methods, and timing (refer to the Logging and Transportation Report and Economic Analysis for the Upper Briggs project). However, through considering all acres in the proposed treatment units, this provides flexibility during implementation to be site specific during project layout to meet the resource objectives in the Upper Briggs purpose and need, while assuring effective protections to resources.

# Regulatory Framework

The proposed action has been reviewed and is determined to be in compliance with the management framework applicable to the soil resource. The laws, regulations, policies and Forest Plan direction applicable to this project and this resource are as follows:

The authorities governing Forest Service soil management are outlined in Forest Service Manual (FSM) 2550 – Soil Management (WO Amendment 2500-2010-1, Effective November 23, 2010) (USFS 2010). Regional direction for maintaining and protecting the soil resource from detrimental disturbance to soil productivity is given in FSM 2520 – Watershed Protection and Management, Region 6 Supplement No. 2500-9801 (USFS 1998).

The Siskiyou National Forest LRMP provides standards and guidelines (S&Gs) for soil and water resources on pages IV-44 through IV-48. In regard to soils and geology, they include S&Gs for detrimental soil conditions, soil erosion, mass movement, and large woody material.

Detrimental soil conditions include compaction, displacement, puddling, and severely burned soil conditions. Detrimental soil conditions are further defined in FSM 2520, Region 6 Supplement No. 2500-98-1. On the Siskiyou National Forest, the total area of detrimental soil conditions should not exceed 15 percent of the total acreage within the activity area, including roads and landings (S&G 7-2, page IV-44) (USFS 1989).

Surface organic matter (duff, litter) is vital for protecting surface soils from erosion. Mineral soil exposure (loss of duff and litter) should not exceed the following limits (ibid.):

- 40% mineral soil exposed on soils classed low-to-moderate erosion hazard;
- 30% mineral soil exposed on soils classed high erosion hazard;
- 15% mineral soil exposed on soils classed very high erosion hazard.

Standards and Guidelines for large woody material stress the importance of addressing site-specific needs. In general, five to twenty pieces of large woody material per acre should remain on each site; material should be from a range of decomposition classes; each piece should be at least 20 inches in diameter at the large end and contain at least 40 cubic feet volume (ibid.). To better guide site-specific needs, additional tools based on Plant Association Groups (PAGs) and down wood information collected with stand exam data, are used to refine the large woody material prescriptions. Because the Forest's PAG data is at a finer scale, the Forest is currently using plant series data from new PAG classifications, delineated by geographical regions (Cascades, Siskiyous, Coast), for determining snag and down wood objectives on the Rogue River-Siskiyou National Forest (refer to the WL report and/or Silviculture Report for more detailed information).

In addition, the Northwest Forest Plan requires that all unstable areas and potentially unstable areas be managed as Riparian Reserve.

## Best Management Practices/Mitigation Measures/Project Design Criteria

The following best management practices/mitigation measures/product design criteria are required to ensure compliance with the regulatory framework for the soil resource and/or to reduce the risk of adverse impacts to the soil resource. A description is provided as to when, where and how the design feature should be applied and/or what conditions would trigger the need to apply the design feature.

The effectiveness and feasibility of the following mitigation measures are assessed based upon the following rating system, shown in Table 2. These ratings are applied to all mitigation measures. Each measure identifies the code for effectiveness and feasibility at the end of the statement or paragraph. Ratings were determined by professional resource specialists, based on current scientific research and/or professional experience or judgment.

**Table 2. Effectiveness and Feasibility Rating System**

**EFFECTIVENESS (E)**

| | |
|---|---|
| **E1** | Unknown or experimental; logic or practice estimated to be less than 75% effective; little or no experience in applying this measure. |
| **E2** | Practice is moderately effective (75 to 90%). Often done in this situation; usually reduces impacts; logic indicates practice is highly effective but there is minimal literature or research. |
| **E3** | Practice is highly effective (greater than 90%). Almost always reduces impacts, almost always done in this situation; literature and research can be applied. |

**FEASIBILITY (F)**

| | |
|---|---|
| **F1** | Unknown or experimental; little or no experience in applying this measure; less than 75% certainty for implementation. May be technically difficult or very costly. May be legally or socially difficult. |
| **F2** | Technically probable; greater than 75% certainty for implementation as planned; costs moderate to high in comparison to other options. Legally or socially acceptable with reservations. |
| **F3** | Almost certain to be implemented as planned; technically easy; costs low in comparison to other options. Legally or socially expected. |

The following discussion by specific resource areas, provide additional mitigation and further explanation of the methodology, effectiveness, and feasibility of the mitigation measures.

## a. Geology

The Northwest Forest Plan Aquatic Conservation Strategy includes unstable and potentially unstable areas within Riparian Reserves. No commercial activities will occur within unstable and potentially unstable terrain. A Geologist, Soil Scientist, or Hydrologist will assist in field validation and identification of additional unstable areas during layout of stand treatments (BMP T-6). **E3/F3**

The FS Sale Administrator will consult with a geologist or soil scientist on any planned new temporary road or landing construction locations before they are approved by the FS. New construction traversing across drainage headwalls and slopes delineated as High or Very High Risk on the slope stability and erosion risk map shall generally be avoided. **E3/F3**

## b. Soils

Mitigation Measures designed for the protection of soils, site productivity, and water quality are generally referred to as Best Management Practices (BMPs) as described in *General Water Quality Best Management Practices*, Pacific Northwest Region, November 1988 (USFS 1988), in concert with the National Core BMP Technical Guide (USFS 2012). While the terminology in the 1988 BMPs is dated (for example Streamside Management Unit now falls under Riparian Reserve), they are still considered effective under today’s management direction. Per the National

Core BMP Technical Guide, this analysis includes site specific BMPs that have been developed for the Upper Briggs project using national, regional, and forest guidance as well as local knowledge of the project area.

Prelocate skid roads in all ground based treatment units; up to 150 feet endlining required to designated skid roads. Skid road locations are to be approved by the Forest Service (BMP T-11). Ground-identified pre-designated skid trail patterns are to be authorized that will limit the area used for harvest access skid trails when employing ground-based harvest systems to ensure compliance with Standards and Guidelines to protect the soil resource and long-term site productivity. **E3/F3**

During operations, heavy machinery use within a treatment unit shall be planned and approved by the Contract Administrator to be consistent with Forest Plan Standard and Guidelines for Soils. The maximum percent of area for detrimental soil conditions under the LRMP is 15% for an activity area (SNF LRMP S&G 7-2). This standard includes roads and landings. **E3/F2**

The use of vehicles and equipment shall be limited to dry soil conditions to minimize compaction. Operating vehicles and harvest equipment on moist soils will cause compaction to be more severe and at greater depths in the soil. Percent moisture levels are to be determined by a Soil Scientist or trained Sale Administrator, using standard soils methodology (such as "Feel Method"), during project layout and implementation. Operations would be suspended when any soil caking, smearing, and/or rutting of approximately 4 to 6 inches begins to occur. **E3/F2**

During implementation, management activities will be designed to retain effective ground cover to protect the soil resource, as specified in the SNF LRMP (1989), and to leave coarse woody material in accordance with the silvicultural prescription. **E3/F2**

Conventional ground-based systems are restricted to slopes of 35% or less. Designated skid trails and skyline corridors are to be spaced at a distance approved by the Forest Service to keep detrimental soil conditions to within the maximum percent of area for detrimental soil conditions under the LRMP; 15% for an activity area (SNF LRMP S&G 7-2). (BMP T-5, T-9, T-11, T-13, VM-1, VM-4). **E3/F2**

All skyline logging will be done with equipment capable of suspending one end of the log; up to 150 foot lateral yarding required to skyline corridors (BMP T-12). Whenever feasible, parallel yarding corridors are preferred over 'fan' settings in order to minimize soil/vegetation disturbance immediately below the yarder. Yarding corridors shall target a spacing of no closer than 150 feet as much as possible (BMP T-12). . An effective slash cover and/or water bars in skyline corridors and skid trails will be installed following the completion of operations for erosion control (BMP T-16). **E3/F3**

During implementation, complete maintenance and erosion control on landings/roads/trails prior to the onset of extended periods of wet weather (BMP T-13, R-18). Restrict haul on roads during extended periods of wet weather. (BMP R-20). **E3/F3**

During implementation, ground-based heavy equipment used for cutting/ skidding/forwarding will be restricted to Forest Service-designated or approved skid trails that are obligated for this use, or to locations where thick slash mats are created using mechanized limbing/topping systems, or to periods when the ground is snow-covered and/or frozen to a depth that minimizes soil compaction. **E3/F3**

During implementation, pre-existing (legacy) skid trails, temporary roads and landings shall be re-used to the extent practicable; so as to minimize additional ground impacts (detrimental soil conditions). Potential re-use of pre-existing templates that are within riparian reserves shall be reviewed by a FS hydrologist and/or soil scientist and would only be approved if long-term benefits of post-treatment restoration of the template outweighs short-term impacts of re-use during project implementation. (BMP T-11). **E3/F2**

No new temporary roads or landings shall be permitted within riparian reserves, to avoid the creation of detrimental soil disturbance and the potential for sediment to reach live water and maintain ACS objectives for management of riparian reserves. **E3/F3**

One or more of the following soil restoration methods shall be used (alone or in combination) to rehabilitate soil conditions on detrimentally disturbed ground (for example, on legacy or newly-designated skid trails, landings and temporary roads) where compaction tests or other monitoring identifies a need for a remedial or impact containment action. (BMP T-14, T-15, T-16, R-23) **E3/F2**:

> After completion of logging, deep subsoiling of heavily compacted skid trails, landings and temporary roads may be employed, where soil conditions are feasible. This operation would use a specially-designed subsoiler implement, mounted on a -tracked excavator, to fracture and loosen compacted soil layers to re-establish water infiltration and deep root penetration. Mechanized equipment used for subsoiling would be restricted to the ground areas already disturbed to avoid creating additional ground impacts.
>
> After completion of logging, scarification (ripping) of skid trails and other disturbed soil areas may be employed. This operation would use standard rock rippers or similar equipment, to superficially cultivate the surface of tractor skid trails as a way to promote natural herbaceous re-vegetation by providing seed catchments and shallow water infiltration.
>
> During subsoiling or scarification, 5 to 10 tons per acre of woody material and/or slash may be placed on top of disturbed ground areas, either manually or with a machine. Dispersing organic material evenly across tractor skid trails, landings, and other bare soil areas reduces erosion and increases water infiltration.
>
> Following completion of logging operations, and in situations where rapid (within months) protection of bared soils is necessary, mulching, grass seeding, shrub planting or tree planting may be conducted using native, non-invasive (and weed-free) grass seed or local native plants (as recommended by a botanist). Optionally, or in combination, sediment capture devices, such as rice straw wattles or bales, may be used to control erosion and reduce sediment movement.
>
> Selection and use of these actions would be based on the existing condition of the site following completion of logging operations. These actions do not result in instant restoration; rather they begin the process of restoration. **E3/F2**

All re-constructed or newly-constructed temporary roads would be reclaimed as soon as practical by the contractor before the storm season, unless mitigated with prescriptions provided on a case-by-case basis from a soils/geology/hydrology specialist. **E3/F2**

Reclamation of temporary roads may include one or more of the following actions: removal of temporarily installed culverts, excavating cross ditches (water bars) to drain water captured by the former running surface, placing large logs or rocks onto the running surface to deter vehicle use, or re-contouring the road template to near-natural ground conditions, as well as any of the soil restoration methods discussed above. (BMP R-23). **E3/F2**

Plan pile burning and prescribed fire operations for when litter, duff, and soil moistures are high enough to minimize consumption of soil organic matter and minimize soil heating. Minimize the size of individual slash hand piles scattered in the units to less than 10 ft. by 10 ft. Distribute piles to reduce severe burn impacts from concentrated fuel. (BMP F-2, F-3). **E3/F2**

During prescribed fire operations, minimize erosion off of constructed firelines by implementin erosion control measures before extended periods of wet weather, and rehabilitating the fire line after the completion of operations. (BMP F-3). **E3/F2**

***Additional PDC's/Mitigation Measures for Ground-based mechanized felling, pre-bunching, and/or forwarding on Steep Slopes***

Use of mechanical cutting/pre-bunching machines will be limited to 35% slopes or less, and shall be approved on a unit-by-unit basis on slopes up to 45% prior to the start of operation, depending on local soil properties, potential for effective slash matting, and proposed equipment. The objective is to limit soil compaction and displacement, to protect the topsoil for vegetative growth, and provide water infiltration. Mechanical cutting/pre-bunching machines shall:

a) Not exceed limits on slope steepness, measured by percent slope (not grade of trail/road). Slope maximum limit is 45 percent, when approved on a unit-by-unit basis, including short steep pitches. **E2/F2**
b) Reduce or eliminate turning and traveling across the slope to minimize soil gouging. **E3/F2**
c) Operate on a slash mat of ground cover or limbs and tops as thick and continuous as practical to minimize soil displacement and compaction. A minimum of 24-inch slash depth is typically necessary to achieve objectives. **E2/F2**
d) Maximize use of single pass trails within the unit; avoid use of multiple pass trails (greater than 2 passes) as much as practicable. Trail spacing for mechanical cutting/pre-bunching will be designed in a manner such that soil disturbance is less than 15% of the activity area. **E3/F2**

The pre-sale layout or marking crew will clearly delineate on the ground, and GPS areas for inclusion on Sale Area Maps prior to operations as much as practicable, where treatment is planned for slopes greater than 35% to avoid excessive soil disturbance from heavy equipment machinery. **E3/F2**

Skid trail percent slope cannot exceed that which the equipment needed to complete erosion control measures (such as construct waterbars, distribute slash cover) can safely travel without causing more negative resource impacts, otherwise erosion control measures must be installed by hand. **E3/F2**

Soil Resource PDC's/Mitigation Measures can be site-specifically adjusted by the soil scientist, in collaboration with other resource specialists, during project implementation if monitoring of soil effects provide data to inform effective adaptive management that continues to meet the objectives of soil resource management, as well as all other resources, in the Upper Briggs analysis. **E3/F3**

***Road decommissioning, storage (convert to ML1), and stream crossing improvement***

During decommissioning and storage activities, unstable road fill slopes will be pulled back adequately to prevent future failure. **E3/F3**

Decommissioned roadbeds and project staging areas are to be left in a condition that prevents channeling of surface flows and allows infiltration suitable for revegetation. **E3/F3**

Stockpile any slash generated from vegetation clearing during road decommissioning, storage, and stream crossing improvement activities to scatter over disturbed sites. Seed exposed soils with an appropriate native seed mix, particularly areas with minimal residual slash cover. **E3/F2**

Before the onset of extended wet weather, install appropriate temporary erosion control measures at incomplete project sites with exposed soil, such as silt fencing or mulch. **E3/F3**

# Affected Environment and Environmental Consequences

## Existing Conditions

### Geology

The Upper Briggs planning area is within the Klamath Mountains Physiographic Province. The bedrock geology of the Upper Briggs planning area consists of three main northeast-trending bands, dissected by multiple northeast-trending faultlines. The western band is made up of the Illinois River Plutonic complex, which includes the Briggs Creek amphibolite, which is thought to be a tectonic slice of metamorphosed oceanic crust. The middle band is made up of rocks of the Galice and Rogue formations, a combination of marine sedimentary and volcanic rocks. Myers Creek, Horse Creek and Secret Creek valleys are located in this area. The eastern band consists of the Onion Camp complex, made up of Applegate amphibolite and a mix of metamorphosed sedimentary and volcanic rocks. Along the fault zones between the Rogue/Galice formation and the Onion Camp complex is a well-defined band of serpentinite. Information for this summary was gathered from Orr et al. (1992), The Briggs Creek Watershed Analysis, Version 1.0 (USFS 1997), and the Oregon Department of Geology and Mineral Industries (DOGAMI) OGDC-5 geographic information systems (GIS) geology layer. Figure 1 displays the geologic mapping of the planning area, and Table 3 provides definitions of the map unit symbols.

### Slope Stability

Mass movement in the Upper Briggs planning area is most commonly shallow landslides, ravel, small-scale slumping and rockfall on steep slopes, particularly in relation to headwater drainages or where disturbance has removed all vegetative cover, and when these steep slopes experience high ground saturation such as during rain-on-snow events. There are four locations in the planning area where large earthflows or deep-seated landslides have occurred in the geologic past at a large-enough scale to be geologically mapped – they are identified in Figure 1 with the symbol “Qls”, landslide debris.

**Table 3. Geologic map unit descriptions.** (DOGAMI OGDC-5)

| Map Unit Symbol | Map Unit Description | Map Unit Symbol | Map Unit Description |
|---|---|---|---|
| am | Onion Camp complex, amphibolite gneiss | ch | Onion Camp complex, chert |
| Jflgb | Illinois River plutonic complex | Jgs/Jgs1 | Galice Formation, siltstone, sandstone, shale and chert |
| Jrb | Rogue Formation, volcanogenic turbidites | Jru | Rogue Formation, undivided marine sedimentary rocks |
| jspd1 | Josephine Ophiolite, serpentinized peridotite | JTram | Country rocks of the Illinois River plutonic complex, Briggs Creek Amphibolite |
| pd | Country rocks of the Illinois River plutonic complex, harzburgite, dunite | pdt | Peridotite |
| Qal | Alluvial deposits | Qls | Landslide debris |
| Qog | Old river gravel deposits | sp/sp1 | Onion Camp complex, serpentinite |
| WTrPz | Western Triassic and Paleozoic Belt, undivided (Applegate Amphibolite; metamorphic/sedimentary/volcanic rocks) | WTRPz | Onion Camp complex, undivided (Applegate Amphibolite; metamorphosed sedimentary/volcanic rocks) |

GIS modelling of the planning area was conducted to help identify the range of risk for potential slope instability and soil erosion risk. This modeling analyzes slope gradient, slope aspect, slope curvature, and upslope contributing area based on the Digital Elevation Model in ArcMap (explained in more detail under the “Methodology” section of this report), to estimate the potential for instability across the planning area landscape. Figure 2 displays the estimated risk, broken out by low, moderate, high, or very high risk for instability.

### *Current Condition Assessment*

During field reviews of the project area, the most noted evidence of relatively recent instability (i.e. within the last several decades) were small isolated slumps occasionally encountered in previously managed stands on particularly steep slopes. In particular, proposed units 63, 64, 118, and 253. They are not widespread or numerous enough to be considered to be affecting overall site productivity, but do indicate the sensitivity of these steep slopes and soils to instability under the right conditions.

A rotational slump is located in the headwall of a headwater tributary to Smith Creek (tributary to Horse Creek), in proposed unit 10, with a large slug of soil/rock debris in the stream drainage where the two uppermost tributaries fork. Based on a review of aerial photography and an extensive field review of the slope and drainage, it appears this slump was last triggered after the stand replacing fire that occurred in the early 1900’s (likely 1930’s). The stand that has grown up on the slope since does not exhibit evidence of active slope movement, and the debris deposit is also vegetated.

Only one of the geologically mapped landslide deposits is in or near any of the proposed activities. Proposed meadow restoration in unit 11 is on the debris fan of an ancient large-scale hillslope failure associated with tectonic fault zones at the contact between the Illinois River plutonic complex/Briggs Creek Amphibolite and the Galice Formation made up of weaker sedimentary rocks.

One of the roads (FSR 2500617) examined for potential decommissioning shows evidence of fillslope cracking and slumping, posing a risk for failure into a tributary stream of Horse Creek.

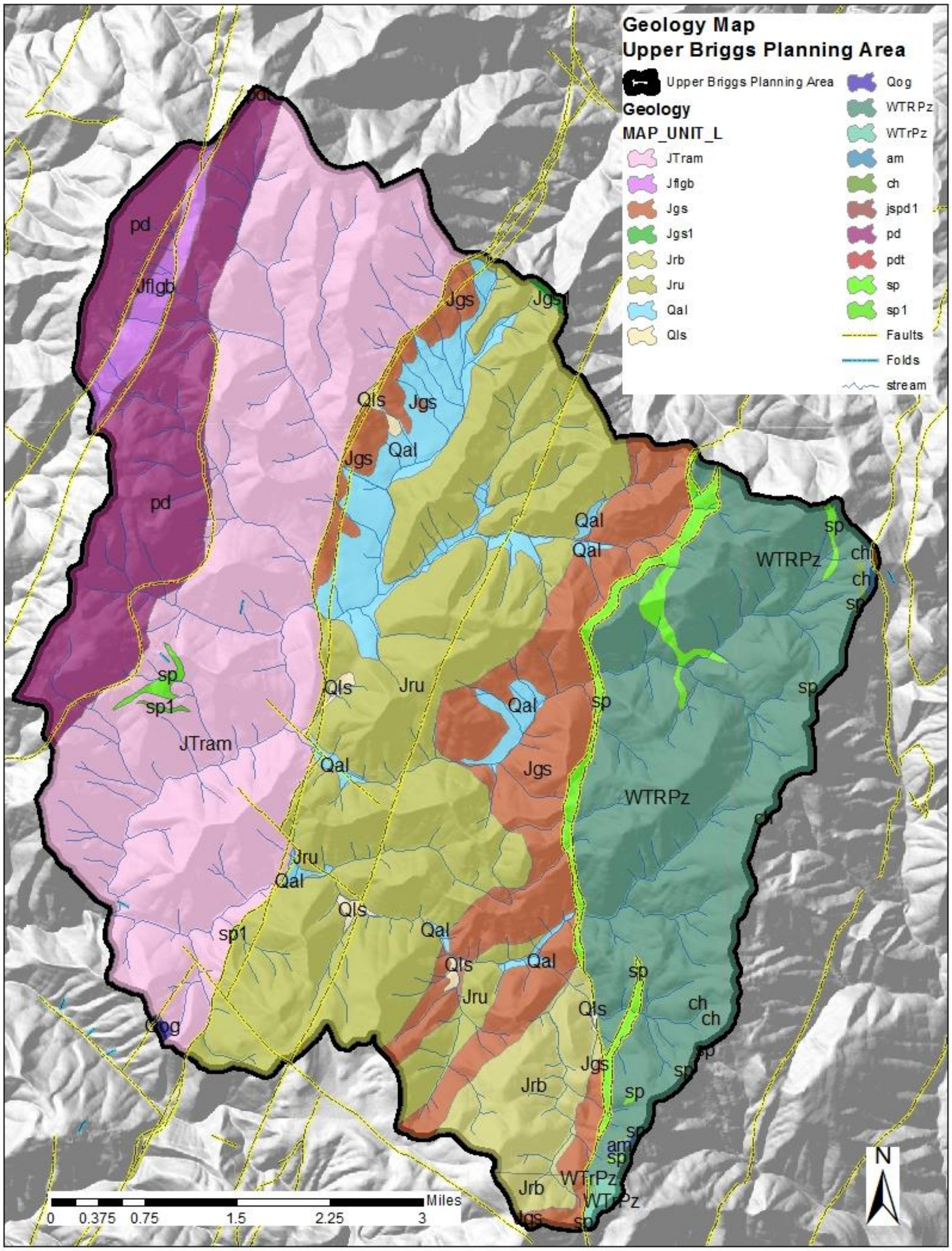


**Figure 1. Geologic map of the Upper Briggs Planning Area.** (DOGAMI OGDC-5)

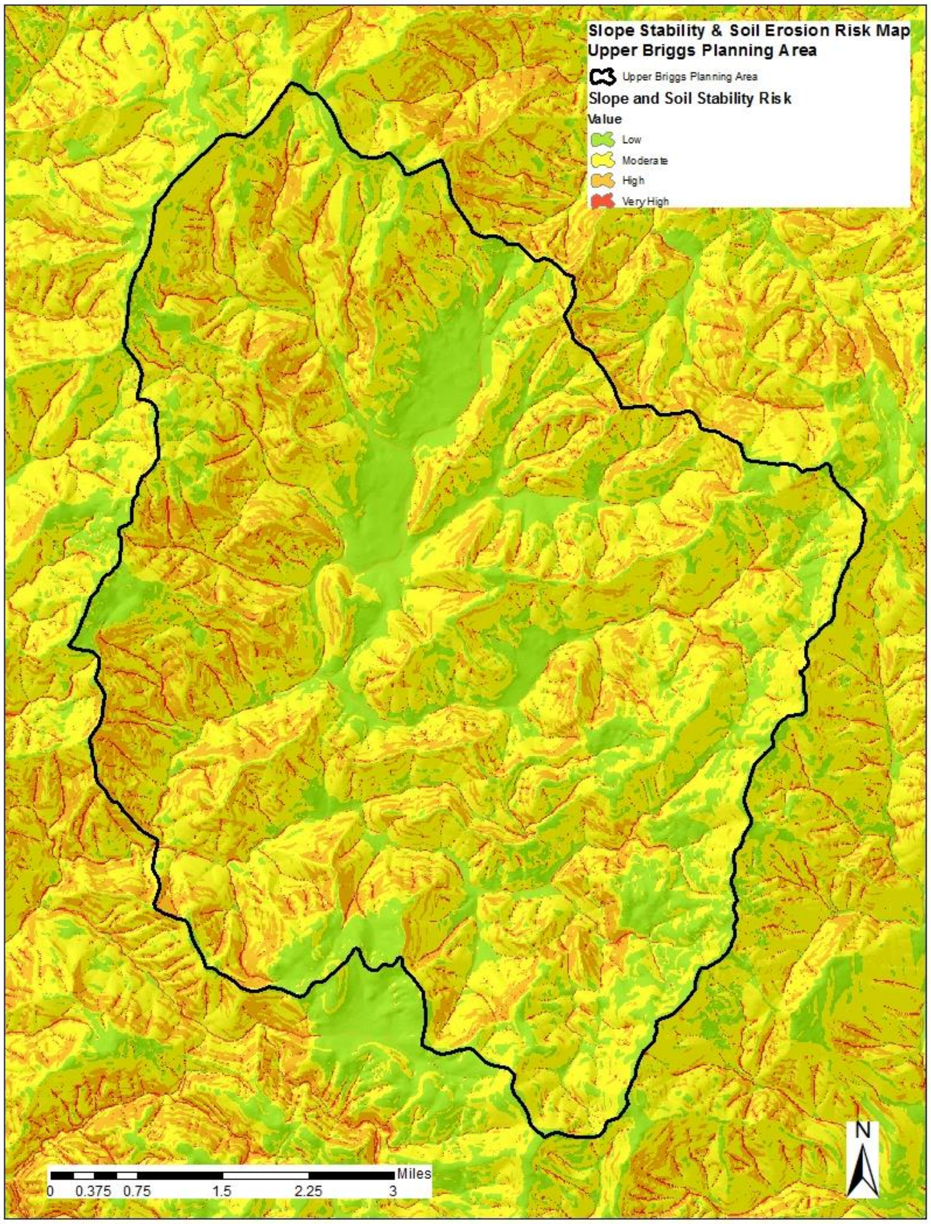


**Figure 2. Slope stability and soil erosion risk within the Upper Briggs planning area.**

## Soil Productivity

Soils within the Upper Briggs planning area were first mapped as part of the Siskiyou National Forest Soil Resource Inventory (SRI) (Meyer and Amaranthus 1979). The SRI provides soil landtype unit information and interpretations that were specifically geared towards forested landscape management, and this information is still pertinent for forest management today. The area was later mapped by the Soil Conservation Service (now the Natural Resources Conservation Service) as part of the Josephine County Oregon Soil Survey (SCS 1989), providing soil survey data that is consistent with national soil survey standards. This analysis utilizes data generated from the Josephine County Oregon Soil Survey, unless specifically noted.

Soils in the planning area are developing on Dissected Mountains landform association, at an elevation range of approximately 2000 to 4400 feet, with average precipitation ranging from 50 to

90 inches, predominately as rain and snow in the winter. Soils are mostly in a mesic soil temperature regime, with highest elevations in the frigid soil temperature regime.

Figure 3 displays the soil map units and their soil taxonomic classification in the Upper Briggs planning area. Alifisol, Inceptisol, Mollisol, and Ultisol soil orders are represented in the planning area. Alfisols form primarily under forest or mixed vegetative cover, and are a result of weathering processes that leach clay minerals and other constituents out of the surface layer and into the subsoil, where they can hold and supply moisture and nutrients to plants. Inceptisols are soils that generally exhibit only moderate degrees of soil weathering and development. Mollisols characteristically form under grass in climates with a moderate to pronounced seasonal moisture deficit, and are soils that have a dark colored surface horizon relatively high in organic matter, are base rich, and quite fertile. Ultisols are soils that form in humid areas, from fairly intense weathering and leaching processes that result in a clay-enriched subsoil dominated in minerals, which, in some of the ultisols in Upper Briggs area, is kaolinite. Ultisols are typically acid soils in which most nutrients are concentrated in the upper few inches. The kaolinitic ultisols in the Upper Briggs area are thought to be remnant alluvial soils that formed along the ancient Illinois River system before the range was uplifted to its present configuration.

Serpentinitic soils in the planning area are those that are forming in ultramafic peridotite/serpentinite parent geologies. These soils are droughty due to high rock content and are very low in fertility. Due to the minerology of the parent rock, the soils have a very high content of magnesium and are very low in calcium, which limits plant growth.

Table 4 lists the soil map units, map unit names, and taxonomy of the soils in the project area for Upper Briggs.

### *Soil Disturbance*

Table 5 displays the relative sensitivities to disturbance of each of the soil map units associated with proposed activities, (Web Soil Survey: http://websoilsurvey.nrcs.usda.gov/), based off of various soil properties.
The following paragraphs give a brief explanation of each rating, summarized from the Descriptions in the Web Soil Survey. Refer to the complete descriptions for more detail.

**Site Degradation Susceptibility**: Rates each soil for its susceptibility for soil degradation to occur during disturbance, seen conversely is the soil's buffering capacity to resist change. Ratings represent relative risk of water and wind erosion, salinization, sodification, organic matter and nutrient depletion and /or redistribution, and loss of adequate rooting depth.

**Soil Compaction Resistance**: Rates each soil for its resistance to compaction, which is predominantly influenced by moisture content, depth to saturation, percent of sand, silt, and clay, soil structure, organic matter content, and content of coarse fragments.

**Soil Rutting Hazard**: This rating indicates the hazard of surface rut formation through the operation of forestland equipment. Soil displacement and puddling may occur simultaneously with rutting. "Slight" indicates soil is subject to little or no rutting; "Moderate" indicates rutting is likely; "Severe" indicates that ruts form readily.

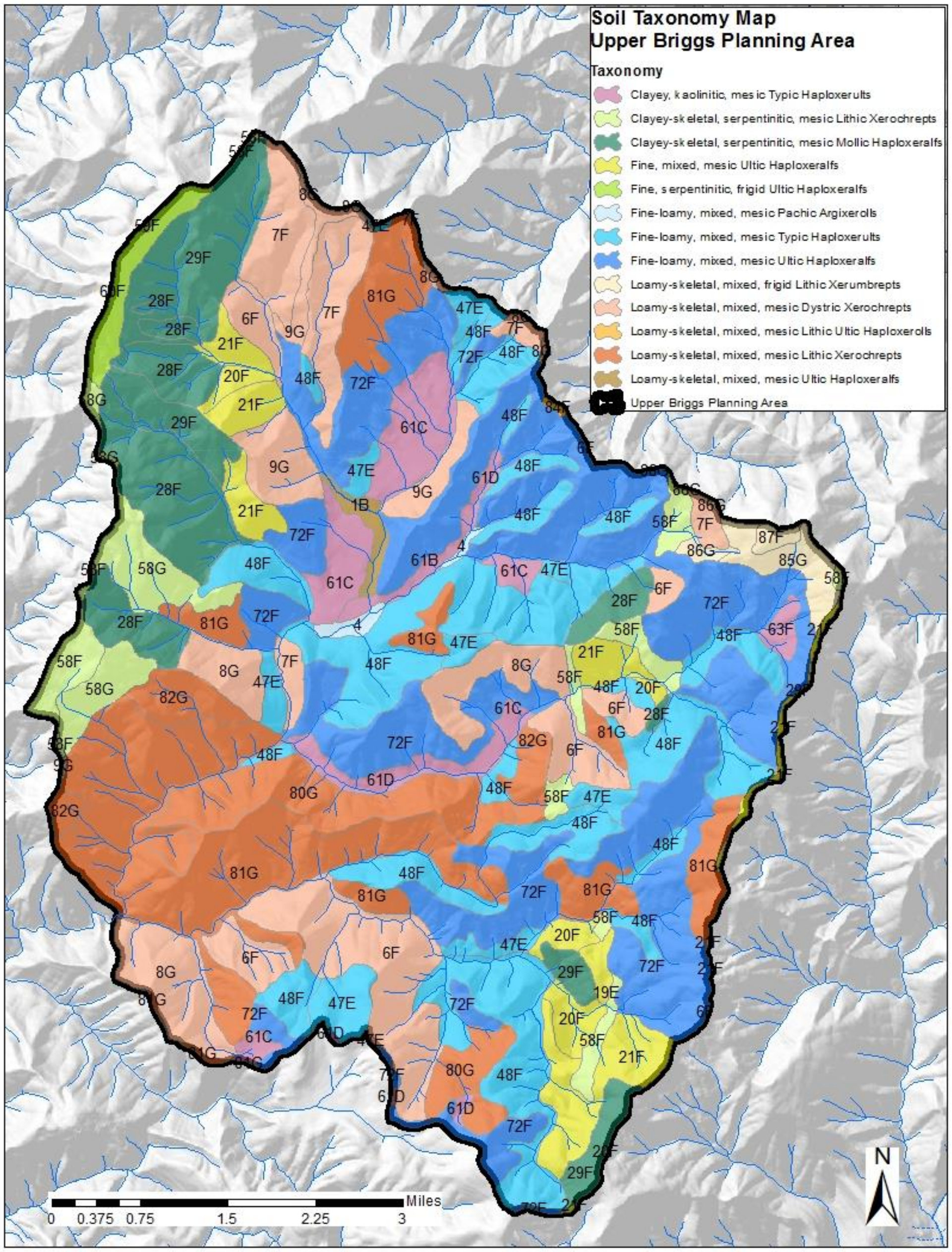


**Figure 3. Soil map of the Upper Briggs Planning Area.** (SCS 1989)

**Table 4. Soil map units in the Upper Briggs project area.** (SCS 1989)

| Soil Map Unit Number | Soil Map Unit Name | Taxonomy |
|---|---|---|
| 1B | Abegg gravelly loam, 2-7% slopes | Loamy-skeletal, mixed, mesic Ultic Haploxeralfs |
| 4 | Banning Loam | Fine-loamy, mixed, mesic Pachic Argixerolls |
| 6F | Beekman-Colestine complex, 50-80% N. slopes | Loamy-skeletal, mixed, mesic Dystric Xerochrepts |
| 7F | Beekman-Colestine complex, 50-75% S. slopes | |
| 8G | Beekman-Vermisa complex, 60-100% N. slopes | |
| 9G | Beekman-Vermisa complex, 60-100% S. slopes | |

| | | |
|---|---|---|
| 21F | Cornutt-Kubakella complex, 35-55% S. slopes | Fine, mixed, mesic Ultic Haploxeralfs |
| 28F | Dubakella-Pearsoll complex, 35-75% N. slopes | Clayey-skeletal, serpentinitic, mesic Mollic Haploxeralfs |
| 29F | Dubakella-Pearsoll complex, 35-70% S. slopes | |
| 47E | Josephine gravelly loam, 20-35% slopes | Fine-loamy, mixed, mesic Typic Haploxerults |
| 48F | Josephine gravelly loam, 35-55% N. slopes | |
| 58F | Pearsoll-Rock outcrop complex, 20-60% slopes | Clayey-skeletal, serpentinitic, mesic Lithic Xerochrepts |
| 60F | Perdin cobbly loam, 30-50% S. slopes | Fine, serpentinitic, frigid Ultic Haploxeralfs |
| 61B | Pollard loam, 2-7% slopes | Clayey, kaolinitic, mesic Typic Haploxerults |
| 61C | Pollard loam, 7-12% slopes | |
| 61D | Pollard loam, 12-60% slopes | |
| 63F | Pollard-Beekman complex, 12-70% slopes | |
| 72F | Speaker-Josephine gravelly loams, 35-55% S. slopes | Fine-loamy, mixed, mesic Ultic Haploxeralfs |
| 80G | Vermisa-Beekman complex, 60-100% N. slopes | Loamy-skeletal, mixed, mesic Lithic Xerochrepts |
| 81G | Vermisa-Beekman complex, 60-100% S. slopes | |
| 82G | Vermisa-Rock outcrop complex, 60-100% S. slopes | |
| 84F | Witzel-Rock outcrop complex, 30-75% slopes | Loamy-skeletal, mixed, mesic Lithic Ultic Haploxerolls |
| 85G | Woodseye very gravelly loam, 50-90% S. slopes | Loamy-skeletal, mixed, frigid Lithic Xerumbrepts |
| 86G | Woodseye-Jayar complex, 50-90% N. slopes | |
| 87F | Woodseye-Rock outcrop complex, 20-60% slopes | |

**Table 5. Sensitivities of Soils in the Upper Briggs planning area to selected disturbances.**

| Map Unit | Site Degradation Susceptibility | Soil Compaction Resistance | Soil Rutting Hazard | Erosion Hazard (Road/Trail) | Erosion Hazard (Off-Road, Off-Trail) | Soil Restoration Potential |
|---|---|---|---|---|---|---|
| **1B** | Slightly | Moderate | Slight | Slight | Slight | High |
| **4** | Slightly | Low | Severe | Slight | Slight | High |
| **6F, 7F, 8G, 9G** | Highly | Low | Moderate | Severe | Very severe | High |
| **21F** | Highly | Moderate | Severe | Severe | Severe | High |
| **28F, 29F** | Highly | Low | Severe | Severe | Very severe | High |
| **47E** | Highly | Moderate | Slight | Severe | Moderate | High |
| **48F** | Highly | Moderate | Slight | Severe | Severe | High |
| **58F** | Highly | Low | Moderate | Severe | Severe | Moderate |
| **60F** | Highly | Moderate | Severe | Severe | Severe | High |
| **61B** | Slightly | High | Severe | Moderate | Slight | High |
| **61C** | Slightly | High | Severe | Severe | Slight | High |
| **61D** | Moderately | High | Severe | Severe | Moderate | High |
| **63F** | Highly | High | Severe | Severe | Moderate | High |
| **72F** | Highly | Low | Moderate | Severe | Severe | High |

| | | | | | | |
|---|---|---|---|---|---|---|
| **80G, 81G, 82G, 84F** | Highly | Low | Slight | Severe | Very severe | Moderate |
| **85G, 86G** | Highly | Moderate | Slight | Severe | Very severe | Moderate |
| **87F** | Highly | Moderate | Slight | Severe | Severe | Moderate |

**Erosion Hazard (Road/Trail)**: Ratings indicate the hazard of soil loss from un-surfaced roads and trails. Ratings are based on soil erosion factor K, slope, and content of rock fragments. "Slight" indicates that little or no erosion is likely; "Moderate" indicates some erosion is likely, and roads/trails may require occasional maintenance, and that simple erosion-control measures are needed; "Severe" indicates that erosion is expected, roads/trails require frequent maintenance, and costly erosion-control measures are needed.

**Erosion Hazard (Off-Road, Off-Trail)**: Ratings indicate the hazard of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface. Ratings are based on slope and soil erosion factor K, with soil loss caused by sheet or rill erosion where 50 to 75 percent of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance.

**Soil Restoration Potential**: Rates each soil for its inherent ability to recover from degradation (i.e., soil resilience). Soil resilience is dependent upon adequate stores of organic matter, good soil structure, low salt and sodium levels, adequate nutrient levels, microbial biomass and diversity, adequate precipitation for recovery, and other soil properties.

Overall, the soils within the Upper Briggs planning area are sensitive to disturbances that can have an adverse effect to soil productivity. Interestingly, these soils also show an inherent ability to recover well from these disturbances, either naturally or through implementation of restoration activities. This has been apparent in field reviews throughout the Upper Briggs project area looking at the residual effects of past actions, discussed in the Current Condition Assessment, below.

### *Soil Water Holding Capacity and Resilience to Drought*

The available water holding capacity of soils is the soil water that is available for plant uptake. It is limited by inherent soil characteristics including soil depth, rock content, texture, and bulk density, as well as influenced by organic matter content. Water storage can be affected by management activities that erode soil, increase bulk densities (i.e. compact the soil, resulting in a loss of pore space), and reduce soil organic matter content. Utilizing available soil survey data, Oregon State University, in cooperation with Region Six of the U.S. Forest Service, created a map displaying the inherent soil water holding capacities of soils in Oregon and Washington, based on the dominant soils in soil map units. Figure 4 displays the available water storage of the soils within the Upper Briggs planning area.

A large portion of soils in the Upper Briggs planning area exhibit very low and low inherent capacity for available water storage. When precipitation is not a limiting factor, such as during an average wet season, or during exceptionally wet years, then despite the inherent droughty nature of the soils, vegetation have access to enough water and there is less competition for this normally limiting resource. However in the Mediterranean climate that is in Southern Oregon, with typically warm, dry summer months, water often becomes a limiting factor during the warm portion of the year. During drought cycles, competition for scarce available water on inherently droughty slopes typically results in vegetation stress and resultant mortality, which becomes

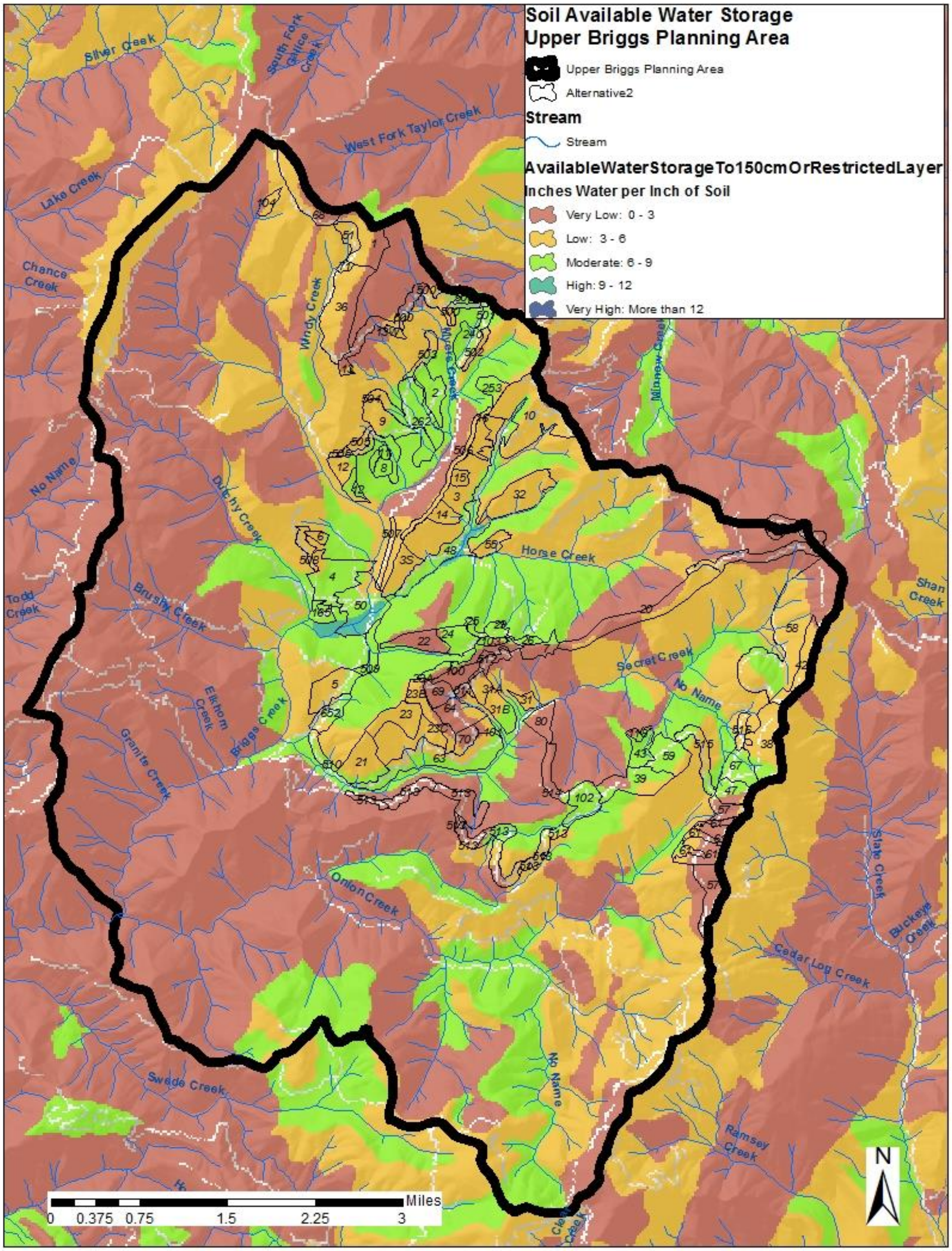


**Figure 4. Available water storage of soils in the Upper Briggs planning area.** This map includes the treatment units proposed in Alternative 2.

exacerbated by stands that have grown more dense during wet periods and from suppression of regular wildfire disturbance.

Moderate and high water holding capacity soils in the Upper Briggs planning area are the deeper and finer textured soils found in the valley bottoms and immediate toe slopes, as well as some north-facing slopes that, through aspect influences on moisture retention, are weathering into deeper soils. These soils have the inherent capacity to hold more available water for plant uptake, for a longer period of time throughout the year. They have a little more resiliency to buffer the effects of drought cycles, though competition between vegetation in stands that have grown up with the suppression of regular wildfire disturbance can still result in stress and mortality during drought periods.

### *Current Condition Assessment*

#### Soil Disturbance

Fourteen of the proposed treatment units are in previously managed stands. Soil monitoring was conducted in 2016 to determine the current condition of the soil resource in these stands based on past management activities that had the potential to create detrimental soil conditions. The monitoring was conducted using the Forest Soil Disturbance Monitoring Protocol rapid assessment (Page-Dumroese et al. 2009). Table 6 summarizes the management history and the results of the soil disturbance monitoring.

**Table 6. Current residual detrimental disturbance in managed stands planned for re-entry.** Note that some units were subdivided for soil disturbance monitoring based on unit size and/or differences in site characteristics across the unit.

| Unit or Sub-unit No. | Soil Map Units | Management History Summary | Soil Disturbance Monitoring – Proportion of Unit/Sub-unit per Severity Class (%) | | | | Proportion of Unit or Sub-Unit Currently Detrimentally Impaired (%) |
|---|---|---|---|---|---|---|---|
| | | | 0 | 1 | 2 | 3 | |
| 8 | 61C | HCC, 1988 | 90 | 0 | 10 | 0 | 10 |
| 63 SE | 8G, 61C, 61D, 72F | HSH, 1972 | 83 | 7 | 3 | 7 | 10 |
| 63 NE | | | 83 | 10 | 7 | 0 | 7 |
| 63 Mid | | | 87 | 10 | 3 | 0 | 3 |
| 63 West | | | 87 | 10 | 3 | 0 | 3 |
| 64 East | 8G, 72F | HCC, 1968 | 97 | 0 | 3 | 0 | 3 |
| 64 West | | | 83 | 17 | 0 | 0 | 0 |
| 71 | 7F | HCC, 1967 | 80 | 10 | 7 | 3 | 10 |
| 80* | 6F, 61C, 72F, 82G | HCC, 1969 | 100 | 0 | 0 | 0 | 0 |
| 102 N | 6F, 47E, 48F, 58F | HCR, 1995; HCC 1980 | 77 | 17 | 7 | 0 | 7 |
| 102 S | | HSV, 1972; HSV, 1990 | 93 | 7 | 0 | 0 | 0 |
| 103 | 8G, 47E, 48F | HFR, 1983 | 93 | 7 | 0 | 0 | 0 |
| 104 | 7F, 29F | HCC, 1958 | 93 | 7 | 0 | 0 | 0 |
| 118 | 6F, 28F, 48F | HCC, 1968 (west side of unit) | 83 | 10 | 7 | 0 | 7 |
| 165 | 4, 48F, 61B, 61C, 72F | HCC, 1954 | 83 | 17 | 0 | 0 | 0 |
| 240 E | 47E, 48F, 72F | HCC, 1959 | 49 | 40 | 9 | 3 | 3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 240 W* | | | 44 | 44 | 11 | 0 | 0 |
| 253 | 48F, 72F | HCC, 1959 | 69 | 28 | 3 | 0 | 3 |
| 262 N | 61C, 72F | HFR, 1982 (most of unit) | 83 | 3 | 13 | 0 | 13 |
| 262 S | | | 73 | 10 | 17 | 0 | 10 |
| 652 E | 48F, 72F | HSV, 1990 | 60 | 17 | 23 | 0 | 17 |
| 652 W | | | 70 | 10 | 20 | 0 | 10 |

*Unit 240W only 18/30 sample points taken; Unit 80 only 23/30 sample points taken

The eastern half of unit 652 exhibited residual disturbance that exceeds the Forest Plan standards and guides for no more than 15 percent detrimental disturbance. In this unit in particular, design criteria and mitigations for activities require that no new disturbance occur, and to mitigate through activities to restore soils in the stand, such as subsoiling to break up compaction. In addition, other stands that are approaching 15 percent, such as units 262, 71, or 8, are encouraged to re-use residual disturbed areas, such as legacy skid trails, as much as possible to minimize increase in detrimental soil disturbance.

### *Soil Water Holding Capacity and Resilience to Drought*

Table 7 identifies the dominant soil water holding capacities for each proposed unit in the Upper Briggs project area. It also identifies the minimum effective ground coverage needed to protect the soils from erosion, based on forest plan standards and guidelines. This organic matter is also important for aiding in the capture and retention of soil moisture. Slopes dominated by low and very low water holding capacities that are currently supporting closed canopy forests that were able to get established during wet climatic cycles and have lacked regular disturbance due to wildfire suppression are not resilient over time due to competition for limited soil water that becomes acute during drought periods. By contrast, High areas are the most resilient. Refer to the Silviculture Report for more information regarding stand productivity in regards to drought vulnerability and stand health.

**Table 7. Inherent water holding capacity of the soils in Alternative 2 proposed units, and effective ground cover minimum protections necessary to protect the soils from erosion.**

| Unit No. | Primary Objective – Alt. 2 | Soil Map Units | Dominant Soil Water Holding Capacity | EGC Minimum Protections* |
|---|---|---|---|---|
| 1 | FMZ | 7F, 8G, 9G, 47E, 81G | Very Low, Low | 85% |
| 2 | DELSH | 72F, 61C | Moderate | 70% |
| 3 | Pine Oak/rare plants | 61B, 72F, 61D | Low | 70% |
| 3S | Rare Plants | 61B, 72F | Low | 70% |
| 4 | DELSH | 61C, 1B, 72F | Moderate, some Low | 70% |
| 5 | DELSH | 72F, 48F | Low, some Moderate | 70% |
| 6 | DELSH | 61C, 72F | Low | 70% |
| 7 | FMZ | 8G, 48F | S. slopes – Very Low, N. slopes - Moderate | 85% |
| 8 | DELSH | 61C | Moderate | 60% |
| 9 | DELSH | 72F, 61C | Moderate & Low | 70% |
| 10 | Pine Oak | 48F, 84F, 72F, 61D | Low; some Very Low & Moderate | 85% |
| 11 | Meadow Restoration | 47E, 61C | Moderate | 60% |
| 12 | DELSH | 72F, 47E, 1B, 61C | Low & Moderate | 70% |
| 12A | DELSH | 47E, 61C | Moderate | 60% |
| 13 | DELSH | 81G, 72F, 7F | Very Low & Low | 85% |
| 13W | DELSH | 81G, 72F | Low | 85% |
| 14 | DELSH | 61B, 72F | Low | 70% |
| 15 | DELSH | 72F | Low | 70% |
| 16 | DELSH | 72F | Low | 70% |

| | | | | |
|---|---|---|---|---|
| 20 | FMZ | 58F, 6F, 28F, 21F, 8G, 72F, 48F | Very Low & Low | 85% |
| 21 | Pine Oak | 72F, 61D | Low; toe slope Moderate | 70% |
| 22 | Pine Oak | 47E, 48F, 81G | Very Low | 85% |
| 23 | Pine Oak | 72F, 48F | Low | 70% |
| 23A | FMZ | 47E, 8G, 48F | S. slope – Very Low; N. slope – Moderate | 85% |
| 23B | FMZ | 72F, 8G, 48F | Low & Very Low | 85% |
| 23C | FMZ | 72F, 8G | Low & Very Low | 85% |
| 24 | DELSH | 47E, 48F, 81G | Moderate | 85% |
| 25 | FMZ | 47E, 48F | Moderate | 70% |
| 26 | FMZ | 8G, 48F | Moderate | 85% |
| 29 | FMZ | 47E, 48F | Moderate | 70% |
| 31 | DELSH | 72F, 61C | Low | 70% |
| 31A | DELSH | 72F, 8G | Low & Very Low | 85% |
| 31B | Riparian Restoration | 72F, 61C | Upper slope – Low; Lower slope - Moderate | 70% |
| 32 | Pine Oak | 48F, 72F | Low | 70% |
| 36 | DELSH | 81G, 7F | Low & Very Low | 85% |
| 38 | FMZ | 48F, 21F, 72F | Low & Moderate | 70% |
| 39 | Pine Oak | 48F, 72F, 6F, 47E | Very Low, Low, & Moderate | 85% |
| 42 | FMZ | 29F, 85G, 21F, 72F, 48F | Low | 85% |
| 43 | FMZ | 48F, 28F | Moderate | 85% |
| 47 | FMZ | 48F, 21F, 81G | Moderate, Low, & Very Low | 85% |
| 48 | Meadow Restoration | 4, 48F, 61B, 72F, 61D | High & Moderate | 70% |
| 50 | Meadow Restoration | 61C, 4, 61B, 72F, 1B, 48F | High, Moderate, & Low | 70% |
| 51 | DELSH | 7F | Low | 85% |
| 55 | Pine Oak | 61C, 48F, 72F | Low | 70% |
| 57 | FMZ | 48F, 72F, 21F, 81G | Very Low & Low | 85% |
| 58 | FMZ | 85G, 58F, 21F, 63F, 72F, 48F | Very Low, Low, & Moderate | 85% |
| 59 | DELSH | 48F, 72F | Moderate; some Low | 70% |
| 61 | FMZ/DELSH | 72F, 48F, 21F, 81G | Very Low & Low | 85% |
| 63 | Riparian Restoration | 72F, 61D, 61C, 8G | Upper slope – Low; Lower slope – Moderate | 85% |
| 64 | DELSH | 72F, 8G | Very Low & Low | 85% |
| 67 | FMZ | 48F, 21F, 72F | Moderate | 70% |
| 68 | FMZ | 7F, 8G, 9G | Very Low & Low | 85% |
| 69 | DELSH | 8G | Very Low | 85% |
| 70 | DELSH | 72F, 8G | Very Low; some Low | 85% |
| 71 | DELSH | 7F | Low | 85% |
| 80 | DELSH | 72F, 6F, 82G, 61C | Very Low | 85% |
| 100 | FMZ | 47E, 8G, 48F | S. slope – Very Low; N. slope - Moderate | 85% |
| 101 | DELSH | 72F, 8G, 61C | Upper 1/3 – Very Low; Mid 1/3 – Low; Lower 1/3 - Moderate | 85% |
| 102 | Pine Oak | 6F, 58F, 47E, 48F | Moderate | 85% |
| 103 | FMZ | 47E, 8G, 48F | Very Low & Moderate | 85% |
| 104 | Riparian Restoration | 29F, 7F | Low & Very Low | 85% |

| | | | | |
|---|---|---|---|---|
| 118 | FMZ | 6F, 48F, 28F | Very Low & Moderate | 85% |
| 165 | DELSH | 72F, 61C, 48F, 4, 61B | Moderate | 70% |
| 240 | DELSH | 47E, 72F, 48F | Moderate | 70% |
| 253 | DELSH | 48F, 72F | Moderate; some Low | 70% |
| 262 | DELSH | 72F, 61C | Moderate | 70% |
| 500 | Roadside FMZ | 81G, 72F, 47E, 8G | Very Low, Low, & Moderate | 85% |
| 501 | Roadside FMZ | 47E, 48F | Moderate | 70% |
| 502 | Roadside FMZ | 72F, 48F, 7F | Low | 85% |
| 503 | Roadside FMZ | 72F, 61C | Low | 70% |
| 504 | Roadside FMZ | 72F, 61C | Low & Moderate | 70% |
| 505 | Roadside FMZ | 72F, 47E, 61C | Low & Moderate | 70% |
| 506 | Roadside FMZ | 48F, 9G, 72F | Low | 85% |
| 507 | Roadside FMZ | 72F, 1B | Low | 70% |
| 508 | Roadside FMZ | 72F | Low | 70% |
| 509 | Roadside FMZ | 4, 48F | Moderate | 70% |
| 510 | Roadside FMZ | 72F, 61D | Moderate & Low | 70% |
| 511 | Roadside FMZ | 72F, 8G | Very Low & Low | 85% |
| 512 | Roadside FMZ | 8G | Very Low | 85% |
| 513 | Roadside FMZ | 81G, 80G, 48F, 61D, 72F | Very Low, Low, & Moderate | 85% |
| 514 | Roadside FMZ | 6F, 82G, 58F, 47E | Very Low | 85% |
| 515 | Roadside FMZ | 48F, 72F | Low & Moderate | 70% |
| 516 | Roadside FMZ | 48F, 72F | Low | 70% |
| 517 | Roadside FMZ | 85G, 87F, 72F, 86G | Very Low & Low | 85% |
| 652 | DELSH | 72F, 48F | Moderate & Low | 70% |

## Environmental Consequences

### No Action Alternative

Under the No-Action alternative, no proposed project activities would take place. No soils would be disturbed from vegetation or fuels management activities. Soils would continue to develop along current trajectories and under natural vegetation and climatic conditions. Disturbed soils from past activities would continue on a passive restoration trajectory. All roads currently on the landscape would remain with the same impacts to soil productivity based on use. The forest floor would remain intact, maintaining effective ground cover, though potentially at levels higher than would naturally exist with natural fire disturbance. Slope stabilities would be commensurate with natural conditions, except where instability is affected by roads, which would have the continued potential to fail if under deferred maintenance and with the right set of conditions. Inherent water holding capacities of soils would continue to influence the vigor of vegetation across the landscape, based on annual precipitation, vegetation densities due to lack of historic fire disturbance and competition for limited water.

### Effects Common to All Action Alternatives

#### *Road Decommissioning, Storage, and Stream Crossing Improvements*

Both action alternatives involve the decommissioning and roadbed restoration of 11.1 miles of national forest system (“system”) roads, the storage (convert to Maintenance Level 1) of 1.6 miles of system roads, and stream crossing improvement of 4 road crossings. Table 8 provides the list of roads and proposed activities.

These activities would result in the long term restoration of soil productivity and elimination of potential slope failures along 11.1 miles of system roads, the reduced potential for slope failures along 1.6 miles of system roads and 4 stream crossings, and temporary improved soil productivity on 1.6 miles of system roads put into storage.

**Table 8.** Roads proposed for a decommissioning, storage, and/or with proposed stream crossing improvement, in the Upper Briggs Restoration Project EA.

| Road Number | Current ML* | Summary of Actions | ML Recommendation | Miles of ML change |
|---|---|---|---|---|
| 2402149 | ML1 | Relocate Trail 1146 Dutchy Creek-Chrome Ridge TH to FSR 2402; restore roadbed, convert to trail 1146 | Decommission | 0.3 |
| 2402150 | ML1 | Relocate Trail 1146 Dutchy Creek-Chrome Ridge TH to RSR 2402; restore roadbed, convert to trail 1146 | Decommission | 0.7 |
| 2402610 | ML1 | Relocate unofficial 1146 TH to FSR 2402; restore roadbed | Decommission | 0.9 |
| 2500099 | ML1 | Improve hydrologic function of Myers Creek tributary stream crossing; restore roadbed from 2500606 junction to end | ML1/Decommission | 0.3 |
| 2500100 | ML2 | Restore roadbed from Windy Creek to end; pull 5 foot culvert & restore Windy Creek channel | Decommission starting at Windy Creek culvert, to end | 0.7 |
| 2500121 | ML1 | Improve hydrologic function at 3 tributary stream crossings to Smith Creek | ML1 | n/a |
| 2500152 | ML1 | Restore roadbed | Decommission | 0.7 |
| 2500160 | ML2 | Restore roadbed | Decommission | 0.8 |
| 2500162 | ML2 | Restore roadbed | Decommission | 0.2 |
| 2500163 | ML2 | Restore roadbed; pull landing fill out of stream channel | Decommission | 0.1 |
| 2500172 | ML2 | Place road into Storage | ML1 | 0.4 |
| 2500175 | ML1 | Restore roadbed | Decommission | 0.7 |
| 2500603 | ML2 | Restore roadbed; pull 3 stream crossing culverts and restore channels | Decommission | 1.0 |
| 2500605 | ML1 | Restore roadbed | Decommission | 0.5 |
| 2500608 | ML1 | Restore roadbed from 2500607 junction to end | Decommission | 0.1 |
| 2500609 | ML1 | Restore roadbed; pull 1 stream crossing culvert and restore channel | Decommission | 0.4 |
| 2500617 | ML1 | Restore roadbed; pull Smith Creek, Horse Creek, and 6 tributary culverts, restore channels | Decommission | 1.5 |
| 2500660 | ML1 | Restore roadbed | Decommission | 0.2 |
| 2500665 | ML2 | Restore roadbed | Decommission | 1.2 |
| 2500667 | ML2 | Restore roadbed | Decommission | 0.1 |
| 2500668 | ML2 | Restore roadbed | Decommission | 0.1 |
| 2500670 | ML2 | Restore roadbed | Decommission | 0.2 |
| 2500671 | ML1 | Restore roadbed | Decommission | 0.2 |
| 2509032 | ML2 | Place road into Storage | ML1 | 0.8 |
| 2509631 | ML2 | Place road into Storage | ML1 | 0.1 |
| 2509632 | ML2 | Place road into Storage | ML1 | 0.1 |

| | | | | |
|---|---|---|---|---|
| 2509633 | ML2 | Place road into Storage | ML1 | 0.2 |
| 2512632 | ML2 | Restore roadbed; convert to trail 1146 | Decommission | 0.2 |

*ML = Maintenance Level

### *Slope Stability*

Road building in forest land is widely recognized as one of the primary causes of debris avalanches in managed forests (Sidle 1980). Roads change the surface and subsurface water flow patterns, which can cause concentrations of flow and soil saturation where it didn't exist before, leading to a slope failure. Roads have the potential to accelerate slumps, earthflows, and possibly creep landslides (Megahan 1986).

The added weight of fill material on steep slopes, combined at times with improperly routed water that causes saturation of the fill slope, often results in eventual failure. Also road cuts in steep, unstable terrain can trigger debris avalanches by removing downslope support.

Road decommissioning, storage, and stream crossing improvement on these identified roads provide an opportunity to minimize risk of slope failures along road prisms, by providing proper drainage, and recognizing and improving areas that are recognized to be at risk of failure. In particular, the decommissioning of FSR 2500617 would eliminate the potential for fillslope failures at multiple channel crossings as well as linear fillslope locations that are currently showing evidence of instability (fillslope cracking and slumping).

Project Design Criteria and Mitigation Measures that have been designed for the Upper Briggs project, including best management practices (BMPs) for temporary and system road activities in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General Water Quality Best Management Practices (USFS 1988), have influenced the planning of road activities during project development, and would be implemented to reduce or eliminate potential future risk on system roads to be decommissioned, put into storage, and storm proofed at stream crossings.

### *Soil Productivity*

Road decommissioning would involve taking the road off the national forest transportation system and restoring the roadbed. Roadbed restoration could include any combination of the following potential actions for road decommissioning: shallow ripping, deep subsoiling, partial to full roadfill pullback/recontouring, mulching/placing slash, pulling cross-drain and drainage culverts and associated fill, shaping stream crossings to natural channel dimensions, water-barring, seeding, planting, and blocking the entrance with a barrier (such as berm construction and/or boulder placement). No ground disturbing actions may be needed where a roadbed is already on a successful passive restoration trajectory.

Road decommissioning provides the opportunity for soils that have been committed to something other than site productivity, to begin to redevelop and support a vegetation community again. While short term effects to soils can include a temporary increased risk of erosion due to loosening the soil, through breaking up deep compaction, water infiltration and gas exchange processes can be renewed, roots are able to penetrate deeper into the soil profile, and soil microbial and nutrient cycling communities and processes can begin to get re-established, resulting in soil productivity restoration over the long term.

"Storage" could include any combination of the following potential actions for converting an open, system road to Maintenance Level 1, closed and put into storage: pulling cross drain and drainage culverts and associated fill, ripping or subsoiling a portion of the roadbed, installing rolling dips, waterbarring, seeding, mulching/placing slash, and blocking the road entrance with a barrier (such as berm or gate). Putting a system road into storage still commits the soil resource to something other than soil productivity over the long term. However, eliminating regular use of the road reduces the potential for surface erosion, as organic matter builds up on the road prism. Over time with continued closure, some shallow rooted vegetation is able to establish in the road prism and temporarily improve productivity, until the road is re-opened.

Stormproofing stream crossings would improve the hydrologic function of these systems and reduce or eliminate the potential for fill failures at the crossings during high flow events, which would reduce or eliminate the potential domino effects of downstream inner gorge slope failures or mass wasting that can occur when road crossings blow out.

## Alternative 2 – Proposed Action

There are 4,017 acres within the proposed vegetation treatment units in Alternative 2. This includes all of the primary management objectives (develop and enhance late seral habitat (DELSH), restore pine-oak communities, restore sensitive plant habitat, restore meadow systems, restore riparian reserves, and create and maintain strategically located fuel management zones (FMZs)). Treatments would involve multiple silvicultural prescriptions, including variable density thinning to 60 or 40% canopy cover, hardwood retention, and ¾ acre maximum patch cuts. Fuels treatments would involve pruning, piling, and burning post vegetation treatment, with underburning 1 to 5 years post treatment. Treatment methods would involve a combination of manual (hand) work, and mechanized equipment including ground-based, cable-yarding, and helicopter equipment. It is estimated that up to 3 miles of temporary roads would be needed to provide temporary access to meet project objectives.

### *Slope Stability*

Slope stability can be impacted by management actions, through actions that alter soil holding strength of root systems through vegetation changes, change drainage patterns through soil movement or compaction, or undermining of slopes. Specific activities as related to the Upper Briggs Restoration project include temporary road construction and reconstruction, silviculture treatments, and fuels treatments.

Figure 5 displays the slope stability and soil erosion risk mapping within the Alternative 2 proposed treatment units, as well as the proposed road decommissioning, storage, and stream crossing stormproofing.

**Temporary Roads**
The effects of temporary roads have the potential to be similar to the effects of system roads (see the discussion of effects under Effects Common to All Action Alternatives). However temporary roads are usually constructed with no engineering specifications since they are targeted to be used for a short time (ideally a single season), and then obliterated. This lack of construction design makes it particularly important to follow project design criteria for avoiding potentially unstable slopes, even with the potentially short time frame of use. That is because even temporary roads which are constructed with road cuts in steep, unstable terrain can trigger debris avalanches and slope failures by removing downslope support and interfering with surface and subsurface water flows that can weaken slopes.

Where there are opportunities to utilize existing non-system road prisms as temporary roads, this provides the benefit of obliterating the route which provides an opportunity to minimize risk of slope failures along road prisms, by providing proper drainage, and recognizing and improving areas that are recognized to be at risk of failure.

Activities proposed in Alternative 2 are expected to need up to 3 miles of temporary roads in order to achieve management objectives. Many of these segments have the potential to re-use existing legacy templates from past management. Project Design Criteria and Mitigation Measures that have been designed for the Upper Briggs project, including best management practices (BMPs) for temporary and system road activities in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General Water Quality Best Management Practices (USFS 1988), have influenced the planning of road activities during project development, and would be implemented to minimize impacts of temporary roads on slope stability.

**Silviculture Treatments**

Through increasing the depth of the saturated zone in the soil, and reducing root strength, the removal of trees can increase slope failures (Megahan 1986). When the majority of vegetation is removed, such as in a clear-cut, the amount of water in the soil profile is increased for a time due to a reduction in plant uptake and transpiration, as well as reduction in canopy interception. Roots increase the strength of soil by helping to bind soil particles together, and to reinforce a soil mass by anchoring it to the underlying bedrock, particularly in shallower soils (Ziemer 1981a). When trees die or are cut, the roots die and decay, resulting in a decline of reinforcement by the roots; approximately 50% of the original root reinforcement is lost within 2 years after deforestation, with 90% gone within 9 years (Ziemer 1981a). However, if only some of the vegetation is removed, such as in a thinning, the loss of root strength is greatly reduced. This is because the remaining trees' root systems are still there to anchor the soils, and they take advantage of the reduction in competition by expanding their root systems (Ziemer 1981b).

It is not expected that there would be an increased chance of slope instability due to the silvicultural treatments planned with the Upper Briggs project, under any action alternative. Silvicultural prescriptions across the treatment landscape would involve variable density thinning to 60% or 40% canopy cover, depending on wildlife habitat needs at the site scale, retention of hardwoods, and patchcuts for dispersal habitat of no greater than ¾ acre, and 20% of stand based on existing vegetation conditions. It is expected that the silvicultural treatments planned would not reduce the density of remaining live tree roots enough to cause a weakening of the soil-root reinforcement. The remaining trees' root systems would respond to the reduction in competition and expand in the soil profile before the root systems of the cut trees had significantly decayed. The promotion of oaks and other re-sprouting hardwood species increases the long-term effectiveness of vegetation adding to slope stability through their root-anchoring capabilities.

**Fuels Treatments**

Underburning could have similar effects as those described for silvicultural treatments, through changes to vegetation as well as the consumption of surface down wood and litter. However, fuels treatments are designed to maintain the overstory canopy the stands are being managed for, as well as to burn with a mosaic of low severity and unburned fuels. Fuels treatments, including pruning, handpiling and burning, are designed to make stands more resistant to stand replacing wildfire effects, which is the kind of disturbance that would be more likely to increase the risk of slope failures. Based on the fuels treatments proposed, it is not expected that there would be a measurable effect from fuels treatments that would result in an increase in slope failures in the project area.

### *Soil Productivity*

Soil productivity can be impacted by management activities, through actions that reduce effective ground cover, displace soil, cause soil compaction or otherwise adversely impact soil structure, destabilize slopes, and change soil water and nutrient cycling processes through vegetation and down wood manipulation. Specific activities as related to the Upper Briggs project include system road reconstruction, temporary road construction and decommissioning, silviculture treatments, fuels treatments, and use of heavy equipment logging systems.

The Siskiyou National Forest Plan standards and guidelines for the soil resource require that no more than 15% of an activity area, including roads and landings, be left with detrimental soil conditions, as well as specific effective ground cover requirements to prevent erosion from mineral soil exposure (refer to the Regulatory Framework in this report). Project design criteria and mitigation measures have been developed specifically for the Upper Briggs Restoration Project to meet these standard and guidelines with implementation of all proposed project activities for all action alternatives.

**Roads**

Of any of the forest management activities being proposed with this project, the temporary and national forest system road network being used/reconstructed/constructed is expected to result in the greatest opportunity for soil erosion per unit area (Megahan 1986). However, project Design Criteria and Mitigation Measures that have been designed for the Upper Briggs Project, including best management practices (BMPs) for road activities in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General Water Quality Best Management Practices (USFS 1988), have influenced the planning of road activities during project development, and would be implemented to minimize impacts of roads on soil productivity.

***Existing System Roads***

Existing system roads are considered a long term commitment of the soil resource to something other than soil productivity. The use of existing system roads during the implementation of this project would not result in a change to the current condition of the soils that are committed to supporting the transportation system. However, where system roads have been closed for a period of years, some level of road reconstruction and maintenance would be necessary to make them suitable for treatment access.

Road reconstruction generally requires the removal of vegetation and the reshaping of the former road prism, possibly including ditches, from a road in disrepair. The road may have achieved some degree of restoration from past use, but whatever that degree, it would be reversed. The conditions of roads needing reconstruction vary greatly, from those with near complete restoration to those with hardly any. Reconstruction of these routes, however, has far less impact to soil productivity (since it had long since been comprised) than to native soil sites, and that is the benefit of reusing them over new construction. Nonetheless, soil is compacted and short-term erosion from newly exposed soils is likely.

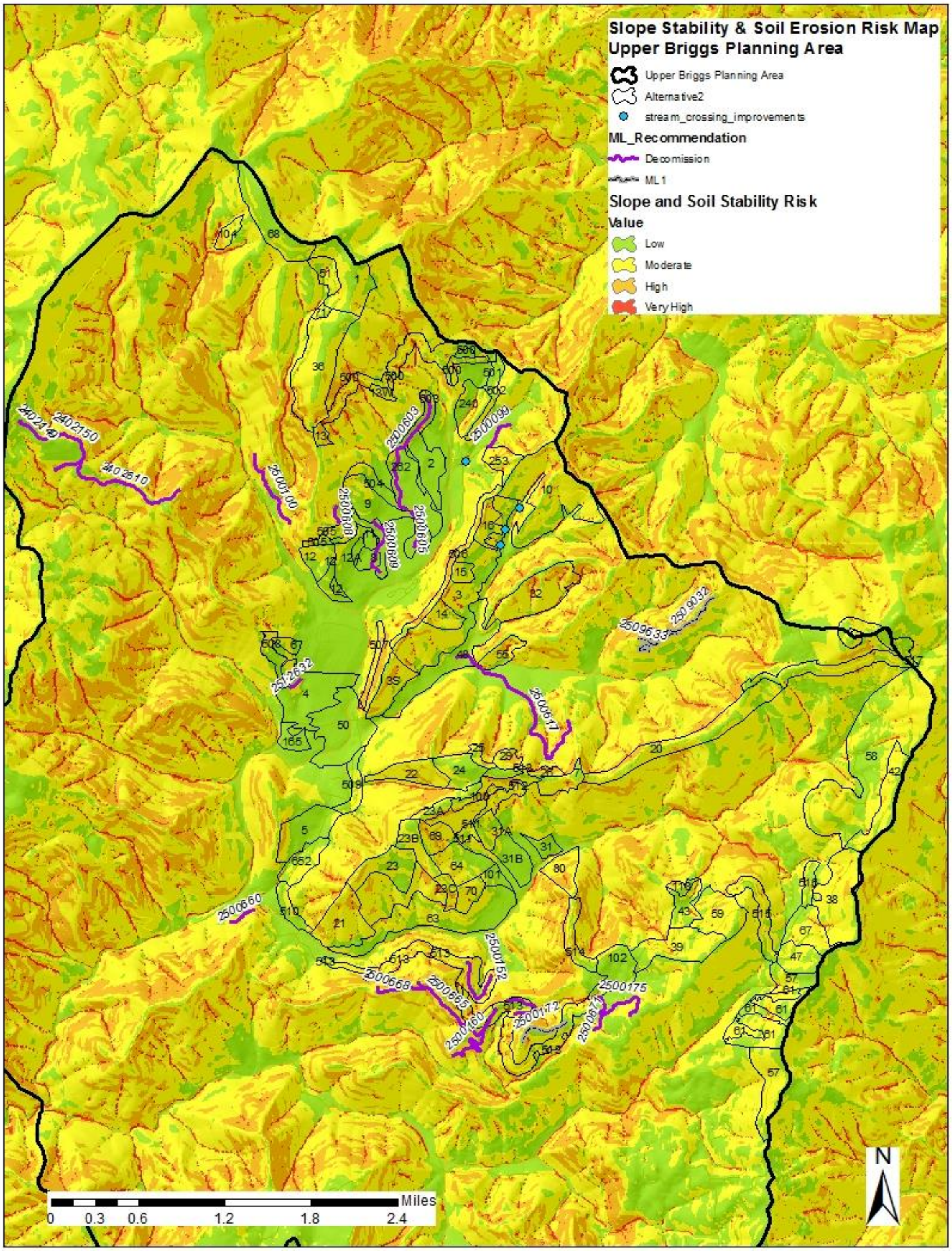


**Figure 5. Slope stability and soil erosion risk map, with Alternative 2 units and road proposals.**

### *Temporary Roads and Landings*

Temporary roads and landings are expected to have an irretrievable reduction in soil productivity since they are bladed (soil is mixed and displaced) and compacted, and increase the potential for soil erosion. Even once rehabilitated, the soil profile is modified to a degree that may take many decades to return to the productive state of the undisturbed forest soils adjacent to it. Landings also, with their likely deep compaction, and soil mixing from construction and recurrent disturbance are expected to produce irretrievable reductions in soil productivity. Nonetheless, their use is temporary, with the expectation that following use they would be returned to the highest degree of productivity reasonably achievable.

Activities proposed in Alternative 2 are expected to need up to 3 miles of temporary roads in order to achieve management objectives. Many of these segments have the potential to re-use existing legacy templates from past management. By re-using old templates, these existing prisms would be obliterated to maximize soil productivity restoration potential of the disturbed sites. No new temporary roads or landings would be permitted within riparian reserves, to avoid the creation of detrimental soil disturbance that could create adverse effects to hydrologic function and soil productivity within riparian areas. Project Design Criteria and Mitigation Measures that have been designed for the Upper Briggs project, including best management practices (BMPs) for temporary and system road activities in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General Water Quality Best Management Practices (USFS 1988), have influenced the planning of road activities during project development, and would be implemented to minimize impacts of temporary roads on soil productivity.

## Silvicultural Treatments

Silvicultural treatments being proposed include variable density thinning to 60 or 40% canopy cover, hardwood retention, and ¾ acre maximum patch cuts. These actions have the potential to affect soil productivity, and organic matter and large woody material through changes to vegetation. Detrimental disturbance as it relates to these silvicultural treatments will be discussed under Harvest Systems, below.

Vegetation uptakes nutrients from the soil in a mostly soluble, inorganic form, and converts them to an organic form for metabolism. Most of a tree’s nutrients are distributed in the leaves, twigs, and branches; as the tree discards leaves, branches, bark, or dies, the plants organic nutrients are returned to the soil. Organic material returned to the soil is decomposed and the nutrients are mineralized (i.e., converted to an inorganic form) by soil organisms depending on the soil’s physical conditions (such as moisture, temperature, aeration, etc…) (Farve and Napper 2009). All of the silvicultural treatments manipulate to various extents the vegetation component that is a part of the nutrient cycle of the soils it is directly growing on. However, since all of these treatments maintain a component of the original forest system, including some overstory vegetation and the forest floor organic litter layer (i.e., they are not harvest systems such as clear-cuts that drastically change the vegetation component), it is not expected that direct or indirect effects to soil productivity as it relates to nutrient cycling would be measurable.

In the forest, precipitation is intercepted, retained, and redistributed by the tree canopy. Water ultimately evaporates from the canopy (interception) or drips through (through-fall) or runs down the stems (stem flow) to the forest floor. Tree canopies intercept precipitation, moderating and metering its fall to the soil surface. They also redirect this intercepted moisture toward the drip line of the tree, and away from the base of the trunk. In extreme rainfall conditions in the absence of deep-crowned tree cover, such as following clear-cut or shelterwood logging, the rate of water striking the surface could exceed the rate of the soil's ability to absorb it, with localized sheet erosion a likely result.

Such effects are generally only relevant to degrees of canopy removal associated with clear-cutting or shelterwood logging, or high intensity stand replacement fire. The treatments in the Upper Briggs Project, however, are variable density thinning, or select removal to form ¾ acre gaps, where a measurable direct or indirect effect of this sort is unlikely, since there would still be various levels of an overstory component directly influencing and providing organics to the soil.

Prescribed amounts of snags and downed wood would be left on a per-acre basis consistent with historical fire regime effects and plant association (plant series) capabilities where existing amounts are below such levels. However, this mitigation is only effective where such snags are available in adequate numbers. Where they are not so available, there would be an opportunity to create more from remaining live trees. Refer to the Wildlife Report for further discussion on snags and downed wood. Snag creation would have a positive effect on long-term soil productivity since snags are a source of future down logs, which are an important component of long-term soil productivity.

Figure 4 displays the water holding capacity of soils with the Alternative 2 treatment units. Table 7 lists each of the treatment units, the primary objective of each unit, and the dominant water holding capacities of the soils within those units and amount of needed effective ground cover.

With Alternative 2, 43 units require 85% effective ground cover, 39 units require 70% effective ground cover, and 3 units require 60% effective ground cover.

### Harvest (Logging) Systems

Logging systems (ground-based, skyline-cable, and aerial) have the potential to adversely impact soil productivity through detrimental compaction, displacement, erosion, and loss of effective ground cover/organic matter. Ground-based systems typically have the greatest potential for effects, whereas aerial systems typically have the least potential for adverse effects.

Project Design Criteria and Mitigation Measures that have been designed for the Upper Briggs project, including applicable best management practices (BMPs) for vegetation management activities in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General Water Quality Best Management Practices (USFS 1988), as well as Regional and Forest level Standards and Guidelines have influenced the planning of vegetation activities during project development, and would be implemented to minimize impacts of harvest activities on soil productivity.

#### *Ground-based Systems (tractor, rubber-tired skidder, harvester-forwarder)*

Ground-based logging systems have the greatest potential to adversely affect short and long-term soil productivity. Logging and other equipment can compact and 'puddle' soils over which they operate (landings, skid roads, roadways, etc). Tractor, or ground based logging has the greatest potential to cause soil compaction, which decreases soil volume and pore space and modifies soil structure and results in a decrease in gas, water, and nutrient exchange, slows root penetration, and can aggravate soil drought, especially in Mediterranean climates such as that of SW Oregon (Atzet et al. 1989), though soil drought may be less of a concern here where there is a much stronger maritime weather influence. Puddling is the destruction of soil structure, primarily when wet, by severe compaction, to the point where ruts or imprints are made and the soil structure has been so destroyed as to prevent water from infiltrating into the soil profile.

Compaction may inhibit occupation of the soil by organisms that assist in the decomposition of wood to soil organic material that improves site productivity, and help to aerate the soil. Compaction also possibly inhibits the growth of beneficial fungi (mycorrhizae) that provide nutrients to plant roots (Keslick 1997). Ectomycorrhizal fungi form an essential interface between soil and trees. They usually colonize more than 90 percent of the feeder roots of host plants (Goodman and Trofymow 1998). Plant development is also restricted in compacted soils due to poor aeration and impeded root growth. As a result, soil productivity is adversely affected (Floch 1988).

Soil moisture content, soil characteristics, and force affect the level of compaction that can occur from harvest systems. Fine-textured soils dominated by expandable clay minerals, and well-graded, coarser textured soils are most likely to compact when moist, whereas finer textured soils dominated by non-expandable clay minerals, and of poorly graded, coarser textured soils such as most pumice and coarse ash soils, are less affected by soil moisture (Atzet et al 1989).

Compaction from logging activities is now routinely mitigated, by designating and minimizing the number of skid trails used; by requiring logging equipment to use only those roads and skid trails created during past timber harvest where feasible; using equipment and or techniques shown effective to prevent or minimize compaction (such as low psi (pounds per square inch) or operating on slash to disperse weight); and allowing operations only during conditions when soils are unlikely to be detrimentally compacted beyond the 15% LRMP allowances (such as on dry or frozen ground; or over deep snow with a firm base). These mitigations have been proven successful and are applied to all Action Alternatives in this project.

Detrimental displacement is defined as the removal of more than 50% of the soil's 'A' horizon (topsoil) from an area greater than 100 square feet that is at least 5 feet in width. This displacement occurs by natural means, such as heavy rains that cause erosion on exposed surfaces (such as skid trails and skyline corridors), or by mechanical means such as churning tractor treads or dragging of logs across the ground. Erosion is a form of detrimental displacement. The majority of erosion occurs by sheet erosion (the even removal of thin layers of soil by water moving across extended areas of gently sloping land) and is difficult to detect, as there are no dramatic effects to alert one to its occurrence. Rills and gullies, however, are dramatic examples of erosion that are easily detected.

Detrimental displacement is routinely mitigated by designating and minimizing the number of skid roads and skyline corridors used; requiring a minimum of one-end log suspension to prevent soil gouging; and placing percent slope limitations on ground-based harvest equipment. Additionally, erosion associated with skid trails and skyline corridors can be effectively mitigated by the placement of cross drains (water bars); drainage dips; placement of down wood and slash; and erosion control seeding (or any vegetative cover on exposed soil). Mitigation measures have been specifically designed for this project. Many have been used for many decades and there has been considerable monitoring and demonstration of their effectiveness.

Large woody material, such as large logs, and standing snags (future large down logs), are important components in the development and retention of productive soils. Snags are routinely felled if they are believed to be a safety hazard to operations. Operation of logging equipment can mechanically damage/destroy downed logs in advanced stages of decay. Logging and burning has the potential to eliminate these features, particularly those in advanced degrees of decay, from the landscape if care isn't taken to retain them in adequate sizes, numbers, and distribution across the landscape. Project Design Criteria for maintenance of snags and downed wood assure that sufficient quantities are retained on the landscape.

### *Skyline-Cable Systems*

Using cables to suspend one or both ends of logs as they are pulled from the stand to the landing largely eliminates the potential for compaction and puddling within the stand. What remains, however, is the potential for detrimental soil displacement if one or both ends of the log are dragged across the ground from the stump to the landing. Full suspension (where the log is lifted entirely off the ground during yarding to the landing) and one-end suspension (where one end of the log is allowed to drag along the ground), are effective mitigations that are now regularly employed to minimize detrimental displacement, as well as the use of a pre-designated skid trail or skyline corridor layout. Skyline systems typically result in approximately 5% or less detrimental soil conditions.

### *Aerial Systems*

Helicopter logging has the least impact of all logging systems on soil productivity. This is a form of full suspension, with no part of the log being drug across the ground, except for very short distances as logs are lifted off the ground from a central point between logs. Such logging eliminates any potential for equipment-generated detrimental soil displacement, compaction, or puddling and their attendant erosion effects. Helicopter logging does, however, require larger, though fewer landings, with the associated compaction and displacement effects typically around 2%.

### *Ground-based mechanized felling, pre-bunching, and/or forwarding on Steep Slopes*

Advances in ground-based harvest equipment technology are making it more possible to safely operate mechanized felling, pre-bunching, and yarding equipment on steeper slopes (greater than 35%), such as through using self-leveling feller-bunchers or tethered harvester-forwarder systems. Industry has been encouraging these developments to increase operator safety as well as increase production and improve economic feasibility, due to the high costs of conventional cable and helicopter systems (Flint and Kellogg 2013, Visser et al. 2013, Acuna et al. 2011). A study in the Coast Range of Oregon looking at the productivity and cost of six different steep slope harvesting systems found that all steep terrain harvester-forwarder systems had the lowest overall harvesting costs, but also that utilizing a specialized steep terrain harvester which processed and pre-bunched for a cable yarding system, caused an increase in productivity of 79% and a reduction in cost of 58% for the cable yarder (Flint and Kellogg 2013). Similarly, a research trial in Australia found that utilizing a self-leveling feller-buncher to fell and pre-bunch stems for cable yarding on slopes between 36-47%, on dry, sedimentary-based soils with good traction, increased productivity of the cable logging operation (Acuna et al. 2011). While both studies resulted in positive outcomes for economics, neither study examined effects of these systems to soil.

Relatively little research has been done to date, to determine the disturbance effects to soil productivity when utilizing steep-slope harvesting systems. Some reviews of the potential slope limitations of various ground-based harvest equipment discuss the safe operating range as related to soil bearing capacity and percent slope (Visser and Stampfer 2015, Visser et al. 2013). Soil bearing capacity focuses on the maximum average contact pressure between the load (in this case, the machine), and the soil which should not produce shear failure. However, this should not be equated to the contact pressure that would result in detrimental soil productivity impacts; it is expected that other detrimental effects would likely result in the soil before reaching the point of vehicle slippage and shear failure. Based on their review, Visser and Stampfer (2015) provide guidelines for slope limits for different kinds of ground-based equipment, but these guidelines focus on safety, not impacts to soils, and they recognize that few studies have been done to quantify disturbance. In their economic study, Flint and Kellogg (2013) recognized the importance of considering the potential effects of soil disturbance, not just the economics, of steep terrain ground-based operations.

A recent study in the western Oregon coast range (Zamora-Cristales et al. 2014) evaluated the effects of two systems, a harvester-cut, cable-yarded unit and a harvester-cut, forwarder-yarded unit, on mineral soil exposure and soil strength on slopes averaging 65% and 58%, respectively. Soils were dominated by very gravelly loams. Operations occurred with soil moistures ranging from 30 to 39% (harvester-cable) and 30-36% (harvester-forwarder). The harvester-forwarder system resulted in two, downhill passes on designated skid trails; the harvester-cable system resulted in one, downhill pass on designated skid trails, with logs being cabled uphill. Steep trails represented 15% of the area in the harvester-cable unit, and 10% of the area in the harvester-forwarder unit. Spacing of trails ranged from 18 to 24 m (approx. 60 to 80 ft.) apart. On harvester-forwarder, 7% of the sample points, and 3% of the sample points in harvester-cable, had exposed mineral soil; the statistical analysis of the data generally confirmed that each harvest unit remained below 10% exposed soil. Regarding soil strength, there was no apparent relationship between changes to soil strength and the percent slope, for either system. An evaluation of the relationship between soil strength and slash showed that operating on slash mats resulted in less increase in soil strength over adjacent undisturbed soil, than operating on no slash. When considering the effects of soil strength on forest site productivity, the soil strength on the 2-pass harvester-forwarder unit trails averaged about 2,770 kPa, whereas the single-pass harvester-cable unit trails averaged about 2,096 kPa. Soil strength levels of about 2,500 kPa or higher are considered to start inhibiting vegetation growth on a variety of soils (Page-Dumroese et al. 2006, cited in Zamora-Cristales et al. 2014). These impacts were only seen within the designated trails, which did not exceed 15% of the area in both units. Dry season operations, only 1 to 2 vehicle passes on trails, and an operating system that added slash to the trails and generally limited ground disturbance, as well as skilled operators, are considered factors that contributed to the results of this study.

On the Fremont-Winema National Forest in south-central Oregon, soil disturbance monitoring was completed on a timber sale unit which was thinned in the summer of 2016 utilizing a tethered harvester and forwarder on wheel tracks (Rone 2017). Average slopes in the unit were approximately 20 to 60%, with soils consisting of coarse pumice which were operated on in dry soil moisture conditions. Shortly after harvest completion, soil disturbance monitoring transects identified 9% and 6% in disturbance class 2 and 3, respectively, which in these soil types the soil scientist considers detrimental soil disturbance (G. Rone, pers. comm.). Initial direct soil disturbance was dominated by soil displacement over compaction, which is related to the coarse, non-cohesive properties of the pumice soil in the unit. Some other operational concerns that were observed were machine side tracking and turning impacts, the disintegration of slash mats, and converging and side-by-side skid trails. Monitoring identified multiple recommendations to help shape project design criteria and mitigations for future steep slope operations, as well as the need to monitor again after a wet season.

The Upper Briggs project is focusing on allowing pre-bunching on slopes greater than 35% but no more than 45%, to assist cable or helicopter yarding, if appropriate equipment and methods are available at the time of implementation. Specifically designed project design criteria and mitigations have been developed to guide the use of this method and assure activities meet soil resource standards and guidelines (refer to Best Management Practices/Mitigation Measures/Project Design Criteria section in this report).

### Fuels Treatments (Activity Fuels and Fuel Management Treatments)

Activity fuels treatment refers to the slash and accumulated fuel resulting from the proposed density management treatments. Activity fuels treatments can include whole tree yarding or leave tops attached and landing pile burning. Fuel management treatments include pruning, piling and burning, and underburning 1 to 5 years post vegetation treatment.

Project Design Criteria and Mitigation Measures that have been designed for the Upper Briggs Project, including applicable best management practices (BMPs) in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General Water Quality Best Management Practices (USFS 1988), as well as Regional and Forest level Standards and Guidelines, have influenced the planning of fuels treatment activities during project development, and would be implemented to minimize impacts of fuels treatments on soil productivity.

#### *Leave Tops Attached / Whole Tree Yarding*

This treatment requires that the top of the tree be yarded to the landing along with the last log (or whole tree if small enough). In some small tree cases, this practice may mitigate the potential for detrimental soil displacement from the dragging log end as the limbs of the top cushion and elevate that end and prevent soil gouging and displacement.

With the increased interest in harvesting biomass, there has been an increased need to understand how removing the branches and needles from the site might be affecting short and long-term soil productivity. Most studies have been based on models and/or nutrient budgets which forecast likely effects; however long-term field studies have also been started. In a review of literature regarding the effects of whole tree harvesting on soil productivity, Farve and Napper (2009) refer to a summary of effects by Waring and Running (2007: 214) that found that "a whole-tree harvest can remove as much as three times the nutrients as compared to a conventional bole-only harvest….however, since the soil nutrient (belowground) pool contains most of the nutrient capital of a forest ecosystem (by several orders of magnitude), in general, removal of the whole tree during timber harvesting should result in only a small percentage of nutrient loss from the forest ecosystem." With implementation of the Upper Briggs Project, where only a portion of trees within a stand are being removed instead of all the trees, the impacts of leaving tops attached is expected to be even less, and likely immeasurable.

#### *Handpile burning / Underburning*

Heat produced during the combustion of aboveground fuels (i.e., dead and live vegetation, litter, duff) is transferred to the soil surface and downward through the soil by several heat transfer processes (radiation, convection, conduction, vaporization, and condensation). As heat is transferred downward into and through the soil, it raises the temperature of the soil. The greatest increase in temperature occurs at, or near, the soil surface. Within short distances downward in the soil, however, temperatures can rapidly diminish so that within 2.0 to 3.9 inches (5 to 10 cm) of the soil surface the temperatures are scarcely above ambient temperature (Neary et al. 2005).

Typical physical effects to soil that can occur from fire include changes to soil structure (particularly as a result of loss of organic matter), changes in porosity and bulk density, loss of cover (i.e., canopy, litter, duff), water repellency, and runoff and erosion vulnerability.

Organic matter plays a key role in soil structure in the upper part of the mineral soil at the duff-upper A-horizon interface, in that it acts as a glue that helps hold mineral soil particles together to form aggregates. Fire can impact the organic matter content in soil by killing the living organisms at temperatures as low as 122 to 140ºF, and by destructively distilling to completely consuming nonliving organic matter at temperatures of 224ºF and 752ºF, respectively (Neary et al. 2005).

Loss of the organic matter component in the soil breaks down the soil structure, which in turn results in a reduction in the amount and size of soil pore space. When the soil structure collapses, it particularly reduces the amount of macropore spaces, and increases the bulk density of the soil, resulting in a loss to soil productivity.

When fire results in the loss of canopy, litter, and duff cover, it exposes the mineral soil to erosion processes. The litter and duff layers also act as an insulator that protects the underlying soil layers from heating, and if they are consumed, it exposes the mineral soil to greater soil heating impacts. Fire-induced water repellency may occur when combustion of organic matter vaporizes hydrophobic organic substances that then move downward in the mineral soil and condenses into a water repellent layer. This in turn increases risk of soil erosion. Water repellent layers have the greatest impact within the first year after fire, as they tend to break down fairly quickly.

Typical chemical effects to soil that can occur from fire include nutrient losses, cation exchange capacity loss, and changes to pH. Nitrogen is the most limiting nutrient in wildland ecosystems, and as such requires special consideration when managing fire. Nitrogen loss increases with increasing temperatures through volatilization, with no loss of N at temperatures below 392ºF all the way up to complete loss of N at temperatures above 932ºF (Neary et al. 2005). The amount of N lost is generally proportional to the amount of organic matter combusted, and burning during moist litter and soil conditions have shown a decrease in the amount of total N lost compared to dry conditions (DeBano et al. 1979; cited in Neary et al. 2005).

Nitrogen that is not volatized either remains as part of the unburned fuels or it is converted to highly available $NH_4$-N that remains in the soil (DeBano et al. 1979; Covington and Sackett 1986; Kutiel and Naveh 1987; DeBano 1991; cited in Neary et al. 2005). This temporary increase in fertility from available N is usually short-lived and is quickly utilized by vegetation within the first few years after burning (Neary et al. 2005).

The cation exchange capacity of soil can be impacted by fire through the destruction of organic matter. The negatively charged particles of organic matter adsorbs otherwise highly soluble positively charged cations, which prevents them from being leached out of the soil. As the amount of organic matter is destroyed from fire, so too is the soils cation exchange capacity.

Cation nutrients (i.e., Ca, Mg, Na, K, $NH_4$) become concentrated in the ash following fire, and can be lost in several ways such as volatization (but this takes very high temperatures), particulate loss in smoke, runoff and erosion, and there can be a long term loss of cations to leaching due to the soils reduction in cation exchange capacity. Cation exchange capacity rebuilds over time with new accumulation of organic matter. The release of soluble cations from the organic matter during combustion can temporarily increase soil pH, but this is dependent in part upon the amount and chemical composition of the ash. Thick layers of ash (termed the ash-bed effect) found from severe burning conditions tends to have the greatest impact on raising soil pH.

Typical biological effects to soil that can occur from fire include loss of microorganisms, loss of meso- and macrofauna, and loss of roots and reproductive structures such as seed banks. Impacts from fire to microorganisms as well as their recovery can be very complex because so many variables are involved. In general it can be stated that “intense wildfire can have severe and sometimes long-lasting effects on microbial population size, diversity, and function", whereas at the other end of the spectrum, "low-severity underburning generally has an inconsequential effect on microorganisms." (Neary et al. 2005). This range of effects is in part related to the amount of organic matter impacted by fire, and the temperature and depth of soil heating. If both of these can be minimized, so will impacts to the microbial population in the soil. Effects of fire to meso- and macrofauna, such as mites, insects, and earthworms, is also highly variable, depending in part on species, habitat and adaptations.

Whether or not plant roots and seed banks are destroyed by fire depends on how deep in the soil they reside, the fire severity and amount of soil heating, and the moisture content of the plant tissues and the soil. Higher moisture content tends to lower the temperature at which living biomass can be killed. Plant tissue can be killed at as low as 104ºF, and seeds can be killed at as low as 122ºF.

Moist soil is a better conductor of heat into the soil so lethal temperatures may extend deeper into the soil surface. However, high moisture content in the litter and duff aids in facilitating a low severity underburn, which results in very little impact to roots and seeds except at the very surface of the litter layer.

Pile/concentrated slash burning increases the residence time of the fire due to concentrated fuels, which can lead to more consumption of organic matter, higher soil heating temperatures, heating deeper into the soil profile, and thus resulting in isolated patches of severely burned soils directly under the slash pile. Mitigations minimizing to the extent possible the size of the piles and burning during moist soil moisture conditions can reduce these impacts by keeping burn temperatures and soil heating as low as possible. Smaller burn scars tend to recover quicker as well due to the high amount of un-impacted soil around them that contribute to recolonization of soil microorganisms and other soil biota.

The *1998 Regional Supplement to the Forest Service Manual (FSM 2520 R-6 Supplement 2500-98-1, Effective August 24, 1998)* defines detrimentally burned soil as:

> "The condition where the mineral soil surface has been significantly changed in color, oxidized to a reddish color, and the next one-half inch blackened from organic matter charring by heat conducted through the top layer. The detrimentally burned soil standard applies to a contiguous area greater than 100 square feet, which is at least 5 feet in width".

Burning of hand slash piles should not exceed the detrimentally burned soil standard since individual burn piles are designed to be discontinuous and not greater than 10 feet in diameter. Even if these burn scars are taken into account, it is expected that less than 2 percent of the area would be left in a severely burned condition.

Detrimental burning occurs when high intensity fire consumes organic matter above and within the soil, heating the soil to the point where the mineral soil surface changes color and the next one-half-inch deeper of soil organic matter is charred. This can happen under natural high-intensity wildfire conditions or by management actions beneath burn piles or 'prescribed burns' when the prescriptions are applied incorrectly or "escape" the parameters of their prescription and become overly intense.

Detrimental burning is most likely under extreme fire weather and dry fuel moisture conditions where fuel accumulations are greatest. Reduction of this fuel through management action decreases the potential of high intensity fire and detrimental burning of the soil. In areas where fuels have been treated (reduced), it is common to have only approximately 20% of the soils in a wildfire-burned area to be in a detrimentally burned condition; this is half of what has been observed in areas where fuels had not been treated.

Large woody material, such as large logs, and standing snags (future large down logs), are important components in the development and retention of productive soils. Burning has the potential to eliminate these features, particularly those in advanced degrees of decay, from the landscape if care isn't taken to retain them in adequate sizes, numbers, and distribution across the landscape.

The purpose of fuel management activities in the Upper Briggs project is to reintroduce fire into a historically fire-adapted landscape, and to make the ecosystems within the area more resilient to impacts from fire over time. Effects to soils from these activities are expected to therefore be within the natural range of variability expected in these fire-adapted ecosystems.

## Alternative 3

There are 2,628 acres within the proposed vegetation treatment units in Alternative 3. This includes all of the primary management objectives (develop and enhance late seral habitat (DELSH), restore pine-oak communities, restore sensitive plant habitat, restore meadow systems, restore riparian reserves, and create and maintain strategically located fuel management zones (FMZs)). Treatments would involve multiple silvicultural prescriptions, including variable density thinning to 60 or 40% canopy cover, thinning from below to maintain 60% canopy cover, hardwood retention, and ¾ acre maximum patch cuts. Fuels treatments would involve pruning, piling, and burning post vegetation treatment, with underburning 1 to 5 years post treatment. Treatment methods would involve a combination of manual (hand) work, and mechanized equipment including ground-based, cable-yarding, and helicopter equipment. It is estimated that up to 0.61 miles of temporary roads would be needed to provide temporary access to meet project objectives.

### *Slope Stability*

Figure 6 displays the slope stability and soil erosion risk mapping within the Alternative 3 proposed treatment units, as well as the proposed road decommissioning, storage, and stream crossing stormproofing.

#### Temporary Roads

Activities proposed in Alternative 3 are expected to need up to 0.61 miles of temporary roads in order to achieve management objectives. Many of these segments have the potential to re-use existing legacy templates from past management. Project Design Criteria and Mitigation Measures that have been designed for the Upper Briggs project, including best management practices (BMPs) for temporary and system road activities in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General Water Quality Best Management Practices (USFS 1988), have influenced the planning of road activities during project development, and would be implemented to minimize impacts of temporary roads on slope stability.

#### Silvicultural Treatments

Silvicultural treatments proposed in Alternative 3 would have the same effects on slope stability as described in Alternative 2, only over less acres. Based on the silvicultural treatments proposed, it is not expected that there would be a measurable effect that would result in an increase in slope failures in the project area.

#### Fuels Treatments

Fuels treatments proposed in Alternative 3 would have the same effects on slope stability as described in Alternative 2, only over less acres. Based on the fuels treatments proposed, it is not expected that there would be a measurable effect from fuels treatments that would result in an increase in slope failures in the project area.

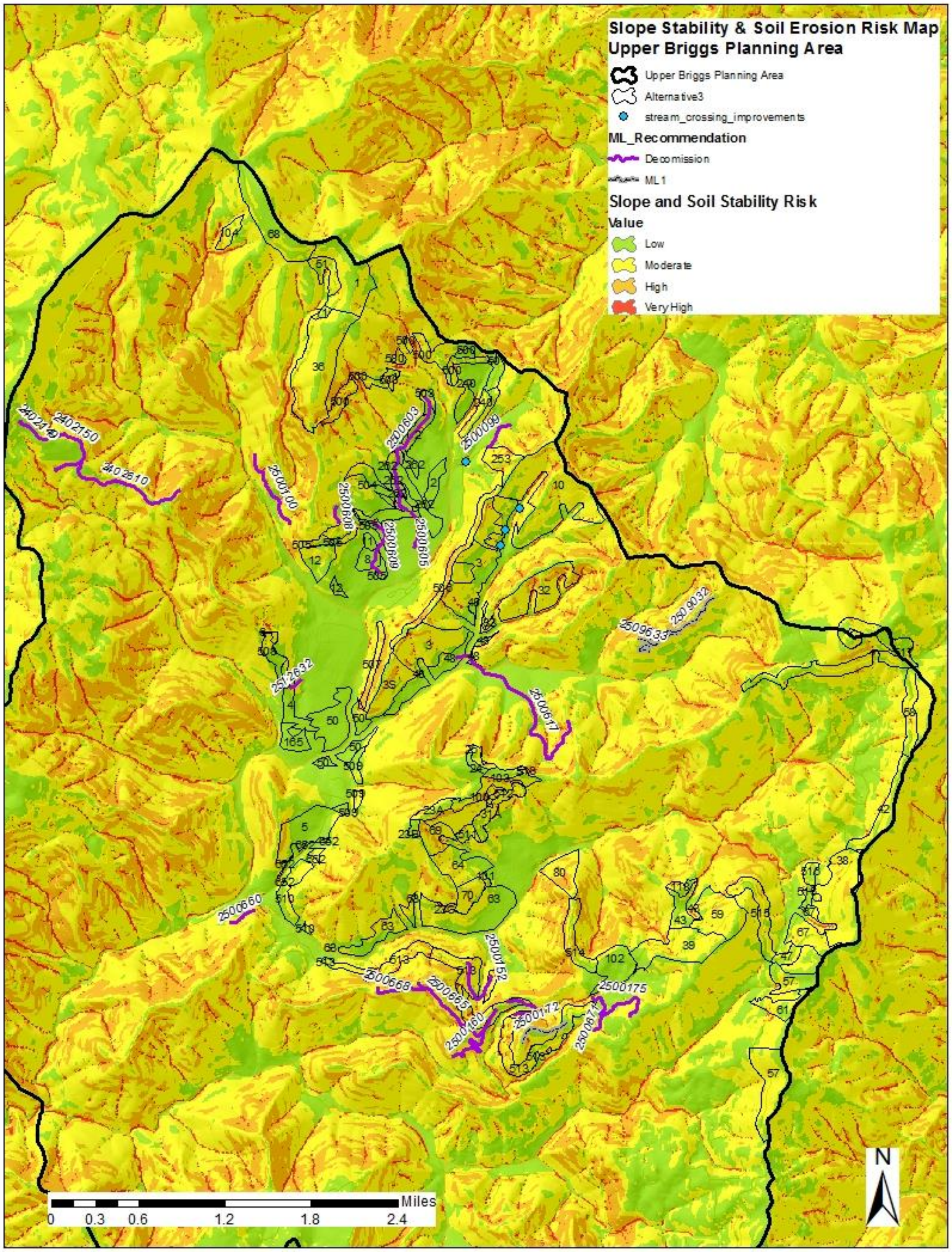


**Figure 6. Slope stability and soil erosion risk map, with Alternative 3 units and road proposals.**

### *Soil Productivity*

Soil productivity can be impacted by management activities, through actions that reduce effective ground cover, displace soil, cause soil compaction or otherwise adversely impact soil structure, destabilize slopes, and change soil water and nutrient cycling processes through vegetation and down wood manipulation. Specific activities as related to the Upper Briggs project include national forest system road reconstruction, temporary road construction and decommissioning, silviculture treatments, fuels treatments, and use of heavy equipment logging systems.

The Siskiyou National Forest Plan standards and guidelines for the soil resource require that no more than 15% of an activity area, including roads and landings, be left with detrimental soil conditions, as well as specific effective ground cover requirements to prevent erosion from mineral soil exposure (refer to the Regulatory Framework in this report). Project design criteria and mitigation measures have been developed specifically for the Upper Briggs Restoration Project to meet these standard and guidelines with implementation of all proposed project activities for all action alternatives.

**Roads**

Effects of existing system roads and temporary roads and landings on soil productivity would be the same as those described under Alternative 2, only with the expectation that overall there would be less effects since less acres are included for treatments in Alternative 3. There would be fewer landings and temporary road miles needed to implement Alternative 3.

**Silvicultural Treatments**

Effects of silvicultural treatments would be the same as those described under Alternative 2, only there would be less effects since less acres are included for treatments in Alternative 3.

Figure 7 displays the water holding capacity of soils with the Alternative 3 treatment units. Table 9 lists each of the treatment units, the primary objective of each unit, and the dominant water holding capacities of the soils within those units and amount of needed effective ground cover.

With Alternative 3, 33 units require 85% effective ground cover, 34 units require 70% effective ground cover, and 2 units require 60% effective ground cover.

**Harvest (Logging) Systems**

Effects of harvest systems, including ground-based, skyline-cable, aerial, and ground-based on steeper slopes, would be the same as those described under Alternative 2, only there would be less effects since less acres are included for treatments in Alternative 3.

**Fuels Treatments (Activity Fuels and Fuel Management Treatments)**

The effects of all of the fuels treatments would be the same as those described under Alternative 2, only there would be less effects since less acres are included for treatments in Alternative 3.

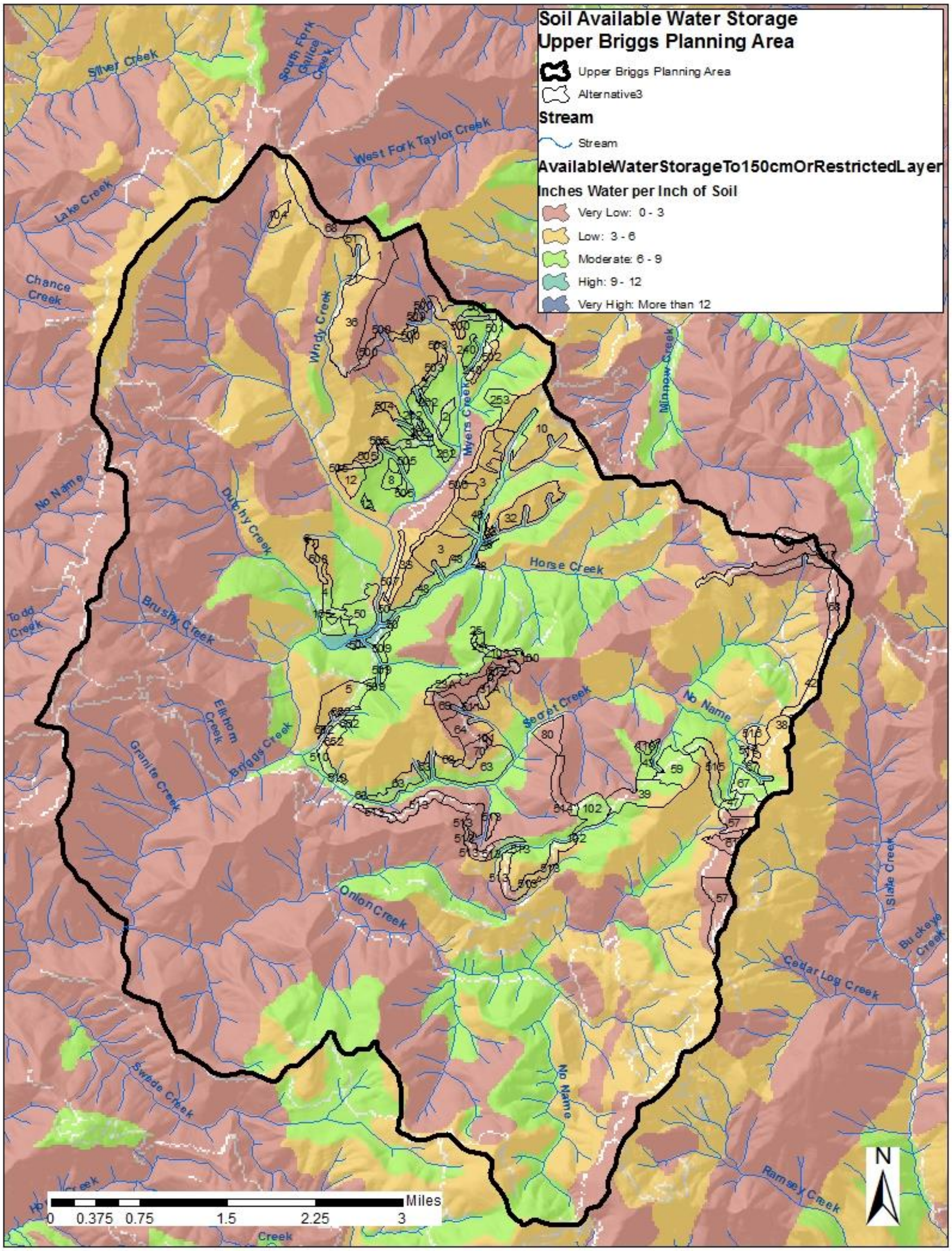


**Figure 7. Water holding capacity of soils in the Upper Briggs planning area.** This map includes the Alternative 3 proposed treatment units.

**Table 9. Inherent water holding capacity of the soils in Alternative 3 proposed units, and effective ground cover minimum protections necessary to protect the soils from erosion.**

| Unit No. | Primary Objective – Alt. 3 | Soil Map Units | Dominant Soil Water Holding Capacity | EGC Minimum Protections* |
|---|---|---|---|---|
| 1 | FMZ | 7F, 8G, 9G, 47E, 81G | Very Low, Low | 85% |
| 2 | Roadside FMZ | 72F, 61C | Moderate, some Low | 70% |
| 3 | Pine Oak/rare plants | 61B, 72F, 61D | Low | 70% |
| 3S | Rare Plants | 61B, 72F | Low | 70% |
| 4 | Roadside FMZ | 61C, 72F | Moderate, some Low | 70% |
| 5 | DELSH | 72F, 48F | Low, some Moderate | 70% |
| 6 | Roadside FMZ | 72F | Low | 70% |
| 8 | DELSH | 61C | Moderate | 60% |
| 9 | Roadside FMZ | 72F, 61C | Moderate; some Low | 70% |
| 10 | Pine Oak | 48F, 84F, 72F, 61D | Low; some Very Low & Moderate | 85% |
| 11 | Meadow Restoration | 47E, 61C | Moderate | 60% |
| 12 | DELSH | 72F, 47E, 1B, 61C | Low & Moderate | 70% |
| 23A | FMZ | 47E, 8G, 48F | S. slope – Very Low; N. slope – Moderate | 85% |
| 23B | FMZ | 72F, 8G, 48F | Low & Very Low | 85% |
| 23C | Roadside FMZ | 72F | Low | 70% |
| 24 | Roadside FMZ | 47E, 48F | Moderate | 70% |
| 25 | DELSH/FMZ | 47E, 48F | Moderate | 70% |
| 31A | Roadside FMZ | 72F, 8G | Low & Very Low | 85% |
| 32 | Pine Oak | 72F | Low | 70% |
| 36 | DELSH | 81G, 7F | Low & Very Low | 85% |
| 38 | FMZ | 48F, 21F, 72F | Low & Moderate | 70% |
| 39 | Pine Oak | 48F, 72F, 6F, 47E | Very Low, Low, & Moderate | 85% |
| 42 | Roadside FMZ | 29F, 85G, 21F, 72F, 48F | Low | 85% |
| 43 | FMZ | 48F, 28F | Moderate | 85% |
| 47 | Roadside FMZ | 48F | Moderate | 70% |
| 48 | Meadow Restoration | 4, 48F, 61B, 72F, 61D | High & Moderate | 70% |
| 50 | Meadow Restoration | 61C, 4, 61B, 72F, 1B, 48F | High, Moderate, & Low | 70% |
| 51 | DELSH | 7F | Low | 85% |
| 57 | FMZ | 48F, 72F, 21F, 81G | Very Low | 85% |
| 58 | FMZ | 85G, 21F | Very Low & Low | 85% |
| 59 | DELSH | 48F, 72F | Moderate; some Low | 70% |
| 61 | FMZ | 72F, 21F, 81G | Very Low & Low | 85% |
| 63 | Riparian Restoration | 72F, 61D, 61C, 8G | Upper slope – Low; Lower slope – Moderate | 85% |
| 64 | DELSH | 72F, 8G | Very Low & Low | 85% |
| 67 | FMZ | 48F, 21F, 72F | Moderate | 70% |
| 68 | FMZ | 7F, 8G, 9G | Very Low & Low | 85% |
| 69 | DELSH | 8G, 48F | Very Low | 85% |
| 70 | DELSH | 72F, 8G | Very Low; some Low | 85% |
| 71 | DELSH | 7F | Low | 85% |
| 80 | DELSH | 72F, 6F, 82G, 61C | Very Low | 85% |
| 100 | FMZ | 47E, 8G, 48F | S. slope – Very Low; N. slope - Moderate | 85% |
| 101 | Roadside FMZ | 8G | Very Low | 85% |
| 102 | Pine Oak | 6F, 58F, 47E, 48F | Moderate | 85% |
| 103 | FMZ | 47E, 8G, 48F | Very Low & Moderate | 85% |

| | | | | |
|---|---|---|---|---|
| 104 | Riparian Restoration | 29F, 7F | Low & Very Low | 85% |
| 118 | FMZ | 6F, 48F, 28F | Very Low & Moderate | 85% |
| 165 | DELSH | 61C, 48F, 4, 61B | Moderate | 70% |
| 240 | DELSH | 47E, 72F, 48F | Moderate | 70% |
| 253 | DELSH | 48F, 72F | Moderate; some Low | 70% |
| 262 | DELSH/Roadside FMZ | 72F, 61C | Moderate | 70% |
| 500 | Roadside FMZ | 81G, 72F, 47E, 8G | Very Low, Low, & Moderate | 85% |
| 501 | Roadside FMZ | 47E, 48F | Moderate | 70% |
| 502 | Roadside FMZ | 72F, 48F, 7F | Low | 70% |
| 503 | Roadside FMZ | 72F, 61C | Low | 70% |
| 504 | Roadside FMZ | 72F, 61C | Low & Moderate | 70% |
| 505 | Roadside FMZ | 72F, 47E, 61C | Low & Moderate | 70% |
| 506 | Roadside FMZ | 48F, 9G, 72F | Low | 85% |
| 507 | Roadside FMZ | 72F, 1B | Low | 70% |
| 508 | Roadside FMZ | 72F | Low | 70% |
| 509 | Roadside FMZ | 4, 48F | Moderate | 70% |
| 510 | Roadside FMZ | 72F, 61D | Moderate & Low | 70% |
| 511 | Roadside FMZ | 72F, 8G | Very Low & Low | 85% |
| 512 | Roadside FMZ | 8G | Very Low | 85% |
| 513 | Roadside FMZ | 81G, 80G, 48F, 61D, 72F | Very Low, Low, & Moderate | 85% |
| 514 | Roadside FMZ | 6F, 82G, 58F, 47E | Very Low | 85% |
| 515 | Roadside FMZ | 48F, 72F | Low & Moderate | 70% |
| 516 | Roadside FMZ | 48F, 72F | Low | 70% |
| 517 | Roadside FMZ | 85G, 87F, 72F, 86G | Very Low & Low | 85% |
| 652 | DELSH | 72F, 48F | Moderate & Low | 70% |

## Cumulative Effects – Alternative 2 and Alternative 3

The cumulative effects analysis area for the soil resource are the proposed vegetation treatment units and proposed road treatments (decommissioning, storage, stream crossing improvement) in the project area, and areas downslope of these areas that could be impacted by soil movement/slope instability. This cumulative effects analysis area is considered sufficient because effects to a particular soil is localized to the defined area where direct and indirect effects can be measured.

Past actions in these areas which still have the potential for residual effects to soils include timber management and wildfires. Timber management has occurred within 14 of the proposed units. These units and their current condition are shown in Table 6, and are included in proposed treatments for Alternative 2 and Alternative 3. Wildfires which overlap proposed treatments and that are recent enough to still have the potential for residual effects to soils include the 2014 Onion Mountain Fire and the 2010 Oak Flat Fire. Detrimental effects from both of these fires would be primarily the loss or reduction of surface organic matter that provides nutrients, water retention, and effective ground cover from erosion on high severity and moderate severity sites. A review of burn severity within overlapping proposed treatments is summarized below:

<u>Road Decommissioning – Both Action Alternatives</u>

- FSR 2402610 and FSR 2402150 are on the northern edge of the Oak Flat fire in predominantly moderate severity.
- FSR 2500660 is in the Oak Flat fire, within moderate severity.

<u>Vegetation Treatments</u>

- Unit 508 is along the eastern edge of the Oak Flat fire, but was mostly unburned and low severity, with a small patch of moderate and no High severity. Roadside FMZ is the primary objective in both action alternatives.
- Unit 10 – the edge of unit 10 along the 2509020 road was within the Onion Mountain fire and was mostly unburned or low severity but on the edge of a patch of high severity. Pine-Oak management is the primary objective in both action alternatives.
- Unit 517 – part of this roadside FMZ was burned, and is dominated by moderate severity burn from Onion Mountain Fire. Roadside FMZ is the primary objective in both action alternatives.
- Unit 20 – part of this unit burned in Onion Mountain Fire, and experienced 2 patches of moderate and high severity surrounded by low and unburned. The primary objective is FMZ in Alternative 2, and is dropped from Alternative 3.

The Siskiyou National Forest Land and Resource Management Plan establishes that the total area of detrimental soil conditions should not exceed 15 percent of the total acreage within the activity area, including roads and landings. Where a unit is already estimated to be over 15 percent detrimentally disturbed (Siskiyou NF Plan, vs. 20 percent in the R6 Manual) from past impacts, the Region 6 Manual requires that “the cumulative detrimental effects of project implementation and restoration must, at a minimum, not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality” (USFS 1998). During preparation for implementation, treatment methods are designed to assure that soil detrimental disturbance will not exceed this Standard and Guideline. In areas where there are residual past effects, then the re-use of old disturbance areas to the maximum extent possible helps to prevent an increase in the acres. In addition, required mitigation measures to improve effective ground cover and water infiltration, such as through slash placement and subsoiling, improve the disturbed areas and set the soil resource on a trajectory of restored soil productivity.

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